Body composition profiles of 14-year-old adolescents attending high schools within the Tlokwe municipality area: The PAHL-study

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It all starts here ™

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Dedication

To my parents, A.J. and J.J Joubert

"*Education is painful, continual, and difficult work to be done in kindness, by watching, by warning, by praise, but above all – by example*".

John Ruskin

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ABSTRACT

Globally, overweight and obesity in childhood has already reached pandemic proportions, and this condition is associated with various health problems such as, insulin-resistance, Type 2 diabetes mellitus, and cardiovascular problems, such as hypertension, ischaemic heart disease, and stroke. Overweight and obesity are increasing in most countries, especially developing countries where the rates of obesity have tripled in those that have adapted a Western lifestyle. In low- and middle-income populations, particularly in urban areas, overweight and obesity in children is on the increase. Thus body composition profiles are used to determine the risk category of children such as underweight, normal, overweight, and obese. Overweight and obesity have a negative impact on both the physical and psychological levels of wellbeing during childhood and adolescence. Research on African and South African children living in rural areas on the body composition and prevalence rates will provide an opportunity to understand the role of development in children and adolescents and the importance thereof. The purpose of this study was to determine the status of body composition and the effect of gender, age, and race on body composition.

This dissertation comprises four chapters, of which one chapter can be read independently as it is written in the form of a research article.

MAIN FINDINGS

A literature review was conducted to gain more insight regarding body composition status of children throughout the world, and in Africa and South Africa, and the role that body composition plays in children and adolescents. The importance of these aspects is highlighted and discussed in Chapter Two.

Cross-sectional data on a total of 280 learners (109 boys and 171 girls) aged 14 years, who are part of the Physical Activity Longitudinal Study from the Tlokwe municipality area, are participants in the study. Body mass, stature, and skinfolds were used to determine body composition and body mass index of the participants. All data was analysed using SPSS Version 21.0 (SPSS Inc., 2012). The statistical level was set at p-value ≤ 0.05.

The results of this study indicate that out of 280 learners 13.1% are overweight, 29.1% normal weight and 57.8% underweight. Boys had a lower overweight value when compared to the girls (9.1% vs 15.7%). In addition, the results show that African girls had a higher prevalence for overweight (15.8% vs 15.4%) than their Caucasian counterparts. As for the impact of gender, age and race-independent effects on body composition or BMI, the results also show no significant ($p \geq 0.05$) age-independent effect on body composition measures of percentage body fat, sum of six skinfolds, fat free mass and waist-to-height ratio.

In conclusion, overweight and obesity is a growing problem among children and adolescents, especially African girls and Caucasian girls in the Tlokwe municipality. Furthermore, recommendations are made about the implementation of school-screening programmes in semi-urban areas. The role of the government, parents, and teachers, and the importance of health professionals must also be considered.

KEYWORDS

Body composition, overweight, obesity, adolescents, and children, underweight.

OPSOMMING

Oorgewig en vetsug tydens die kinderjare het reeds wêreldwyd pandemiese proporsies bereik en dit word ook geassosiëer met verskeie gesondheidsprobleme bv. Insulien-weerstandigheid, tipe 2 diabetes mellitus en kardovaskulêre probleme soos hipertensie, iskemiese hartsiekte en beroerte. Oorgewig en vetsug neem toe in meeste lande, veral ontwikkelende lande en die tempo van vetsug het verdriedubbel in hierdie ontwikkelende lande wat 'n Westerse lewenstyl aangeneem het. In lae-inkomste en middel-inkomste populasies, spesifiek in stedelike gebiede, is oorgewig en vetsug besig om te verhoog in kinders. Derhalwe kan die liggaamsamestelling-profiele gebruik word om die risiko faktore van kinders te bepaal, soos ondergewig, normaal, oorgewig en vetsugtig. Oorgewig en vetsug het 'n negatiewe impak op 'n fisieke en psigologiese vlak van welstand tydens die kinder-en tienerjare. Navorsing op Afrika en Suid-Afrikaanse kinders wat in stedelike gebiede woon, is nodig om die geleentheid te bied om die rol van ontwikkeling in kinders en tieners en die belangrikheid daarvan te verstaan. Navorsing op liggaamsamestelling en voorkomsyfer sal dit vir ons bied. Die doel van hierdie studie was om die status van liggaamsamestelling vas te stel en die effek van geslag, ouderdomenras op liggaamsamestelling.

Hierdie skripsie is saam gestel uit vier hoofstukke waarvan een hoofstuk onafhanklik gelees kan word aangesien dit in die vorm van 'n navorsingsartikel geskryf is.

Belangrikste bevindings

Die literatuuroorsig is gedoen om meer insig te verskaf rakende die liggaamsamestellingstatus van kinders in die wêreld, Afrika en Suid-Afrika. Die rol wat liggaamsamestelling speel in kinders en tieners is belangrik, daarom word hierdie aspekte beklemtoon en bespreek in hoofstuk twee.

Die dwars-deursnee data van 280 leerlinge (109 seuns en 171 dogters), ouderdom 14 jaar wie deel was van die Fiesieke Aktiwiteit Longtudinal Studie van Tlokwe munisipaliteit area het aan die studie deelgeneem. Liggaamsmassa, lengte en velvoue is gebruik om die liggaamsamestelling en liggaamsmassa-indeks vas te stel van die deelnemers. Alle inligting is ontleed deur SPSS version 21.0 (SPSS Inc., 2012). Die statistiese vlak is gestel op p-waarde ≤ 0.05.

Die resultaat van hierdie studie duiaan dat uit 280 leerders 13.1 % oorgewig is, 29.1 % normale gewig en 57.8 % ondergewig is. Wanneer seuns en dogters vergelyk word, het seuns 'n laer oorgewigs-waarde as dogters (9.1 % vs 15.7 %). Met byvoeging tot die resultate word daar aangetoon dat nie-blanke Afrika dogters 'n hoër voorkoms syfer, wat oorgewig aanbetref, (15.8 % vs 15.4 %) het as die blanke dogters. Die impak van geslag, ouderdom en ras onafhanklike effek op liggaamsamestelling of Liggaams-massa-indeks: die resultate toon geen noemenswaardige ($p \geq 0.05$) ouderdom onafhanklike effek op liggaamsamestellings meting van liggaamsvetpersentasie, som van twee velvoue, vet vrye massa en lengte tot massa-verhouding nie.

Ter afsluiting, oorgewig en vetsug is 'n enorme probleem by kinders en tieners, veral in nie-blanke en blanke dogters in die Tlokwe munisipaliteit. Verder word aanbevelings gemaak oor die implementering van skool keuring programme in semi-stedelike gebiede. Die rol van die regering, ouers en onderwysers, en die belangrikheid van gesondheid van werkers/personeel moet ook inaggeneem word.

Sleutelwoorde

Liggaamsamestelling, oorgewig, vetsug, tieners, kinders, ondergewig.

PREFACE

Format of dissertation

The article format was selected for the current dissertation. All references follow the latest Harvard style guidelines. The article will be submitted to the Mediterranean journal of social sciences. Author guidelines are attached as Appendix A.

AUTHORS' CONTRIBUTION

The principle author of this dissertation is Mr. J.D. Joubert. The contribution of each of the co-authors involved in this study is summarised in the following table:

Co-author	**Contribution**
Professor J.H. de Ridder	Promoter, supervisor. Co-reviewer, assistance in writing of manuscripts, selection of study, design, and planning of manuscripts and general guidance.
Professor M.A. Monyeki	Co-promoter, co-supervisor and principal investigator in the PAHL-study. Assistance in writing of manuscripts, general recommendations, and interpretation of results and data analysis and statistics.

The following is a statement from the co-authors confirming their individual roles in the study and giving their permission that the manuscript may form part of this thesis.

I declare that I have approved the abovementioned manuscript and that my role in the study, as indicated above, is representative of my actual contribution and that I hereby give my consent that it may be published as part of the Masters of Science dissertation of J.D. Joubert.

Professor J.H. de Ridder

Professor M.A. Monyeki

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LIST OF ABBREVIATIONS

%BF	Percentage Body Fat
ACSM	American College of Sports Medicine
BM	Body Mass
BMI	Body Mass Index
DEXA	Dual Energy x-ray absorptiometry
FFM	Fat Free Mass
FTO	Fat mass and obesity gene
ISAK	International Society for the Advancement of Kinanthropometry
Kg	Kilograms
m	Meters
mm	Millimetres
N	Sample size
NWU	North-West University
PAHLS	Physical Activity and Health Longitudinal Study
SD	Standard Deviation
SPSS	Statistical Package for the Social Sciences
SSK	Sum of Two Skinfolds
WHO	World Health Organization
WHR	Waist-to-hip circumference ratio
WHtHR	Waist-to-height-ratio

CHAPTER 1: PROBLEM STATEMENT, OBJECTIVES, AND HYPOTHES

1.1 INTRODUCTION

Obesity and overweight is a worldwide epidemic in children, adolescents and adults, and is the fifth leading risk for global deaths (WHO, 2013:311). Worldwide obesity has nearly doubled since 1980 (WHO, 2013:311). One of the major concerns is that children who are obese tend to become obese adults (Hills & Kagawa, 2007:111). In 2008 more than 1.4 billion adults aged 20 years and older, were overweight and of these, over 200 million men and nearly 300 million women were obese (WHO, 2013:311). The previous statistics also show that 35% of adults aged 20 and over were overweight in 2008, with 11% obese; the same report also indicated that 40 million children under the age of five were overweight in 2011 (WHO, 2013:311). In the year 2000 statistics showed that obesity in children and adolescents had increased drastically in developing countries (WHO, 2000:265), and stated that if this was not addressed the trend would continue to adulthood. The sudden increase in childhood obesity is caused by many factors, among others, sedentary lifestyles and poor nutrition (Sherman, 2002:9). Obesity is associated with risk factors of cardiovascular disease (mainly heart disease and stroke), diabetes mellitus, musculoskeletal disorders (especially osteoarthritis), as well as some cancers (endometrial, breast and colon) (WHO, 2013:311).

Overweight and obesity are defined by WHO as abnormal or excessive fat accumulation that presents a risk to an individual's health. Body mass index (BMI) is a simple index of weight-to-height that is commonly used to classify overweight and obesity in adults (WHO, 2013:311). In addition, several anthropometric procedures such as waist-to-hip circumference ratio (WHR) and extremity-to-trunk skinfold ratios may also be used to describe body fat distribution (Moreno *et al.,* 1997:180). WHR is a simple method commonly used to quantify adipose tissue distribution. Increased WHR is used to indicate a preferential accumulation of adipose tissue in the abdominal region or upper body. Consequently, the terms "upper body obesity" or "abdominal obesity" have been widely used as synonymous with increased WHR (Abate & Garg, 1995:65). Extremity-to-trunk skinfold ratios provide information on subcutaneous body fat distribution. Both triceps-to-subscapular and biceps-to-subscapular skinfold thickness ratios reflect the relative distribution of fat in the subcutaneous compartment.

1.2 PROBLEM STATEMENT

It has been well established that most disturbances related to abdominal obesity have their onset during childhood (Gillum, 1987; Legido *et al.,* 1989; Flodmark *et al.,* 1994). However, limited data exists concerning reference values for these indices, especially in paediatric literature (Weststrate *et al.,* 1989; Martínez *et al.*, 1994). Recently, waist-to-height ratio (WHtR) has been used as another measure of fatness distribution, particularly in children and adolescents (Seeja & Kumari, 2009:137), though limited research studies are available. WHtR is found to be associated with cardiovascular risk factors, hence conducting a research study on WHtR will help to shed more light by contributing to the paediatric literature.

Kemper *et al.* (2001:185) recommend the need to address lifestyle risk factors and anthropometric measurements during adolescence for effective early treatment. It is important to quantify the stability of a characteristic over time from a public-health perspective in longitudinal research. To improve health, its importance is evident in the effectiveness of a lifestyle intervention. If the stability of a characteristic is high, the level is usually hard to change and therefore, the intervention in this particular characteristic is ineffective. Furthermore, if it is possible to track existing risk factors, the subject at risk can be identified at an early age, and therefore preventative strategies can be started as soon as possible, with a better chance of success (Monyeki *et al.,* 2008*:406*).

The prevalence of obesity among British, European and Australian children is high (Parsons *et al.,* 1999:52; Cattaneo *et al.,* 2010:389; Olds *et al.,* 2010:57; WHO, 2012). Modern lifestyle in an obesogenic environment is associated, among others, with an increased prevalence of obesity among children (Baur*,* 2000:S3). The even greater problems of poor dietary and inactivity patterns cause changes that result in higher obesity levels, and these changes are experienced by certain population groups (Wang *et al.,* 1998:908; WHO, 2012).

A study has shown that distribution of body fat for both adults and children in the central area of the body is associated with Type 2 diabetes mellitus, a worse cardiovascular disease profile, and other adverse outcomes (Daniels *et al.,* 2000:1179). Body composition changes drastically in males as well as females during the adolescent years and both genders show significant body weight increases during this time. In females, weight velocity occurs 6-9 months later than the peak height velocity, whereas in males both peak height and weight velocity occur at the same time (Hills & Kagawa, 2007:112). Some of these changes include an increase in body fat as well as bone mineral development (Hills & Kagawa, 2007:113; Van Lenthe, 1997).

Freedman *et al*. (1987:403) reported 26 years ago that the male pattern of upper-body obesity, characterised by a thick skinfold of the nape of the neck relative to the sacral region, was strongly related to increased levels of insulin, diabetes, and atherosclerosis, when compared to lower body obesity patterns in females. The effects of upper-versus lower body obesity have also been examined by using the ratio of waist-to-hip circumference, which focuses mainly on abdominal fat distribution. A high waist-to-hip ratio is associated with increased levels of triglycerides and glucose, as well as an increased risk of diabetes, in addition to which it is predictive of future cardiovascular diseases. With skinfold thickness measurements, a preferential deposition of truncal fat is related to subsequent coronary heart disease. Obesity located in the central area of the body is related to increased levels of triglycerides and blood pressure, as well as an increased prevalence of diabetes. If a thick subscapular skinfold is detected, there is an increased risk of subsequent cardiovascular disease and diabetes mellitus (Freedman *et al.*, 1987:403). According to the World Health Organisation (WHO, 2008) abdominal adipose tissue (central adiposity) is related to a range of metabolic abnormalities. Among these abnormalities are a deceased glucose tolerance, reduced insulin sensitivity, and adverse lipid profiles, which are risk factors for Type 2 diabetes and cardiovascular disease. Thus it is suggested that waist circumference, waist-hip ratio and waist-height ratio (which reflects abdominal adiposity), are more accurate than BMI in predicting cardiovascular disease. However, WHO also stated that no anthropometric measurement is more strongly associated with blood pressure, plasma glucose, diabetes and lipid levels than BMI, although it appears to be less informative than other measurements (WHO, 2008).

Some body fat is located subcutaneously, and regression equations which estimate the percentage of body fat (Norton*,* 1996:190) are used to measure this. Since the democratic election in 1994, according to previous studies (Cameron & Getz, 1997:775), an increase in the prevalence of childhood obesity has been reported in black children of South Africa. The evidence makes it clear that there is an increasing tension between the need for physical education programmes to reflect global trends and the maintenance of culturally relevant themes. In today's world (which is a globalised society), information and knowledge is transmitted in a rapid fashion. If such knowledge and information (especially as it relates to best practice), is not embraced and employed it could place physical education programmes and other related advocacy physical activity programmes at a disadvantage (Edginton & Chin, 2013:1). It is clear that an investigation is needed to track the endemic occurrence in this population.

The ***research questions*** to be answered with this study therefore are:

1. What is the body composition profile of 14-year-old adolescent boys and girls residing within the Tlokwe local municipality?
2. What is the effect of gender, age, and race on body composition of 14-year-old adolescent boys and girls residing within the Tlokwe local municipality?

The answer to these research questions will provide valuable information on which programmes on physical education can be provided by professionals (physicians, biokinetics, etc.) to warn against hypertension, cancer and Type 2 diabetes. Studies during adolescence would also add support to all the primary assumptions made for early interventions to prevent risk factors of non-communicable diseases before behavioural patterns are fully established and resistant to change.

1.3 RESEARCH OBJECTIVES

The objectives of this research were to determine the:

- Body composition profiles of adolescent boys and girls (African and Caucasian) residing in the Tlokwe local municipality.
- The effect of gender, age, and race on body composition of 14-year-old adolescent boys and girls residing within the Tlokwe local municipality.

1.4 HYPOTHESIS

This study was based on the following hypotheses:

- The body composition profiles will show a low prevalence of obesity and fatness levels among adolescent boys residing in the Tlokwe local municipality, while conversely, a high prevalence of obesity and fatness levels will be evident among adolescent girls residing in the Tlokwe local municipality.
- The impact of gender, age, and race on body composition will show significant effects on body composition, and no significant age-independent effect on body composition

measures of percentage body fat, sum of two skinfolds, fat free mass, and waist-to-height ratio.

1.5 STRUCTURE OF THE DISSERTATION

The dissertation was submitted in article format as approved by the Senate of the North-West University, and was structured as follows:

Chapter 1:	Introduction (problem statement)
Chapter 2:	Literature review – Body composition in children: a review.
Chapter 3:	**Article 1:** Body fat composition profile of 14-year-old adolescents attending high schools within Tlokwe municipality area: the PAHL-study (Article will be submitted to: Mediterranean Journal of Social Science).
Chapter 4:	Summary, conclusion, limitations, and recommendations.

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CHAPTER 2: BODY COMPOSITION IN CHILDREN: A REVIEW

2.1. INTRODUCTION

Body composition might seem an obscure branch of physiology or anatomy; not as exciting as other branches of science which are in the public consciousness. A closer look at body composition indicates a vibrant, dynamic area of research which targets the entire spectrum of scale from the atom to the population. It is definitely not seen as a dry, static science (Stewart, 2012:1). The history of body composition dates back to the 1900s. The first body composition study (systematic) was in 1921, when Jindrich Matiegka developed a method of quantifying bone, muscle, and adipose tissue, together with residential mass (Matiegka, 1921:227). Major efforts to compartmentalise the body's constituents, and the body's phenotype and physique were investigated by a number of different individuals, relating different body shapes to discrete patterns of body types, which generally recognised slenderness, muscularity, and fatness separately (Stewart, 2012:4).

It is clear that body composition classifies different body types and by extension, classes of obesity. William Sheldon (1898-1977) who was accredited for the term "somatotype", contended that a person's physique was predestined, thus developing a physique classification system. It was based on nude photographs of Ivy League students with the body in standard poses. There was plenty of controversy over the procedure and the use of the photographs, thus the collection was destroyed (Stewart, 2012:4). Physique classification was later developed using anthropometry. The densitometric method was developed for body fat prediction purposes during the 1970s and 1980s. Large studies involving skinfolds which were used to predict fat content as measured by underwater weighing, were developed in the UK by Durnin & Womersley in 1974. During the 1980s a further dimension was added with the advent of the Brussels Cadaver study. This enabled the estimation of muscle and bone, as well as adipose tissue, skin and fat with the dissection of a cadaver. However, the challenges of predicting body composition in living humans meant that its relevance was called in to question. Thus the development of the dual x-ray absorptiometry (DXA) emerged at the start of the 1990s, with the capability for total and regional examination of the body in vivid composition. It is clear how body composition has changed throughout the ages and how important it is to determine chemical or physical components of an organism, such as different classes of obesity.

2.2. DEFINITION AND CONCEPT CLARIFICATION

Body composition is considered by many to mean "level of fatness". Its definition is much wider than this: "the chemical or physical components that collectively make up an organism's mass, defined in a systematic way" (Stewart, 2010:455). ACSM defines body composition as the following: "Basic body composition can be expressed as the relative percentage of body mass that is fat and fat-free tissue using a two-compartment model" (ACSM, 2010:62). ACSM also stated that measurements of height, weight, circumferences, and skinfolds are used to estimate body composition. Although skinfolds are a more difficult anthropometric procedure than any other, they provide a more accurate estimate of body fatness than those based only on height, weight, and circumference (Lohman *et al.*, 1997:33). Bushman (2011:5) defines body composition as the total body makeup.

Bushman also explains that the body is made up of lean tissue (muscle) and fat tissue, and that the focus of body composition is the relative amount of muscle versus fat. It is clear that from the above definitions that lean tissue refers to muscle and fat tissue refers to fat. It is also clear that an increase in body fat leads to overweight and obesity (figure 2-1). There are a number of definitions for overweight/obesity which have been published: "Obesity is an excess accumulation of adipose tissue containing fat in the form of triglycerides" (Queen & Lang, 1993:587; McArdle *et al*., 1994:853). "The accumulation of fat is a visible manifestation that more food energy has been stored than has been expended" (Bray, 1990:491; Epstein *et al*., 1996:428). "Obesity can be defined as a disease in which excess body fat has accumulated, to an extent that health may be adversely affected" (Forbes, 1995:46; WHO, 1998:276). "Overweight and obesity are defined as abnormal or excessive fat accumulation that presents a risk to health" (WHO 2007*a*:311).

The literature also shows a difference between overweight and obesity: Overweight refers to body mass greater than a specific value of mass for body length. Obesity refers to an over-accumulation of fat tissue (Schonfield-Warden & Warden, 1997:340; Troiano & Flegal, 1999:522). The difference between children and adults with regard to obesity is that some adults were fat as children, so that child fatness may be a risk factor in its own right for later disease. It is important to understand one important difference between childhood and adulthood in the assessment of fatness, and that is that children grow in size, so that anthropometric cut-offs for fatness need to be adjusted for age, and in adolescents for maturation as well (Powers *et al.,* 1997:508).

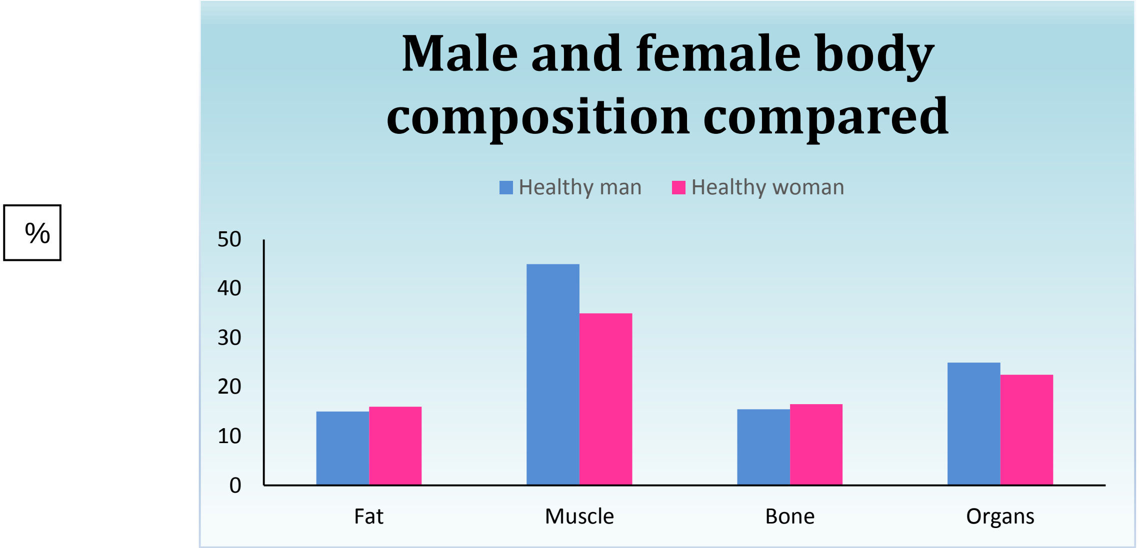


Figure 2-1: Male and female body composition compared (Whitney & Rolfes, 2008:261).

2.3 CLASSES OF OBESITY IN CHILDREN AND ADOLESCENTS

2.3.1 Introduction

Overweight and obesity are terms both used to describe certain situations in which body weight is higher than research recommends for optimal health (Kruskall, 2011:265). Overweight is when an individual body mass (body weight) is higher than expected for someone of in ratio to their height (stature), and obesity refers to weighing a great deal more than expected (Kruskall, 2011:265). Measurements ranging from skinfold thickness, clinical assessments, weight-for-age, body mass index, and waist-to-hip ratio, etc. are used to determine overweight/obesity. (De Onis & Lobstein, 2010:459). BMI is the most commonly used index, although not a perfect anthropometric indicator of weight status. When BMI is used to assess adults, it is fairly straightforward compared to BMI's of children which differ at different ages. Thus in children, overweight and obesity is usually expressed as BMI-for-age (De Onis & Lobstein, 2010:459).

Table 2-1: Classification of disease risk based on body mass index (BMI) and waist circumference, (Rimm et al., 1995:1123; ACSM, 2010:63).

		Disease risk relative to normal weight and waist circumference	
	BMI ($kg \cdot m^{-2}$)	**Men, ≤102cm Women, ≤88cm**	**Men, >102cm Women, >88cm**
Underweight	<18.5	-	-
Normal	18.5 - 24.9	-	-
Overweight	25.0 - 29.9	Increased	High
Obesity, class			
1	30.0 - 34.9	High	Very high
2	35.0 - 39.9	Very high	Very high
3	≥40	Extremely high	Extremely high

To be more specific, BMI or body mass index is used to classify subclasses: underweight, normal, overweight, and obese (Table 2-1). Anthropometric methods are used to measure height, weight, circumference, and skinfolds. Skinfold measurements are more difficult to measure than other anthropometric procedures but provide a much better estimate of body fatness (ACSM, 2010:63).

2.3.2 Body mass index (Quetelet index)

Body mass index (BMI)or Quetelet index is calculated by dividing body weight in kilograms by height in meters squared ($kg.m^2$), and is used to assess weight relative to height (ACSM, 2010:63).

$$BMI = \frac{\text{Body mass (kg)}}{\text{Body length (m)}^2}$$

Although it is an indirect method, using waist circumference and BMI provides quick insight into body composition (Berger, 2011:28).

2.3.3 Body mass index to age

There are different factors that influence BMI results in children and adolescents, such as race, gender, age, maturation, and growth. As children and adolescents are still growing, their height (stature) changes constantly which influences the BMI result. Thus WHO (1995:854) suggests that the phase of puberty is considered when BMI is used for chronological age interpretation.

Bini *et al*. (2000:214) devised a method to factor in puberty phase and biological age to determine BMI (Figures 2-2 and 2-3).

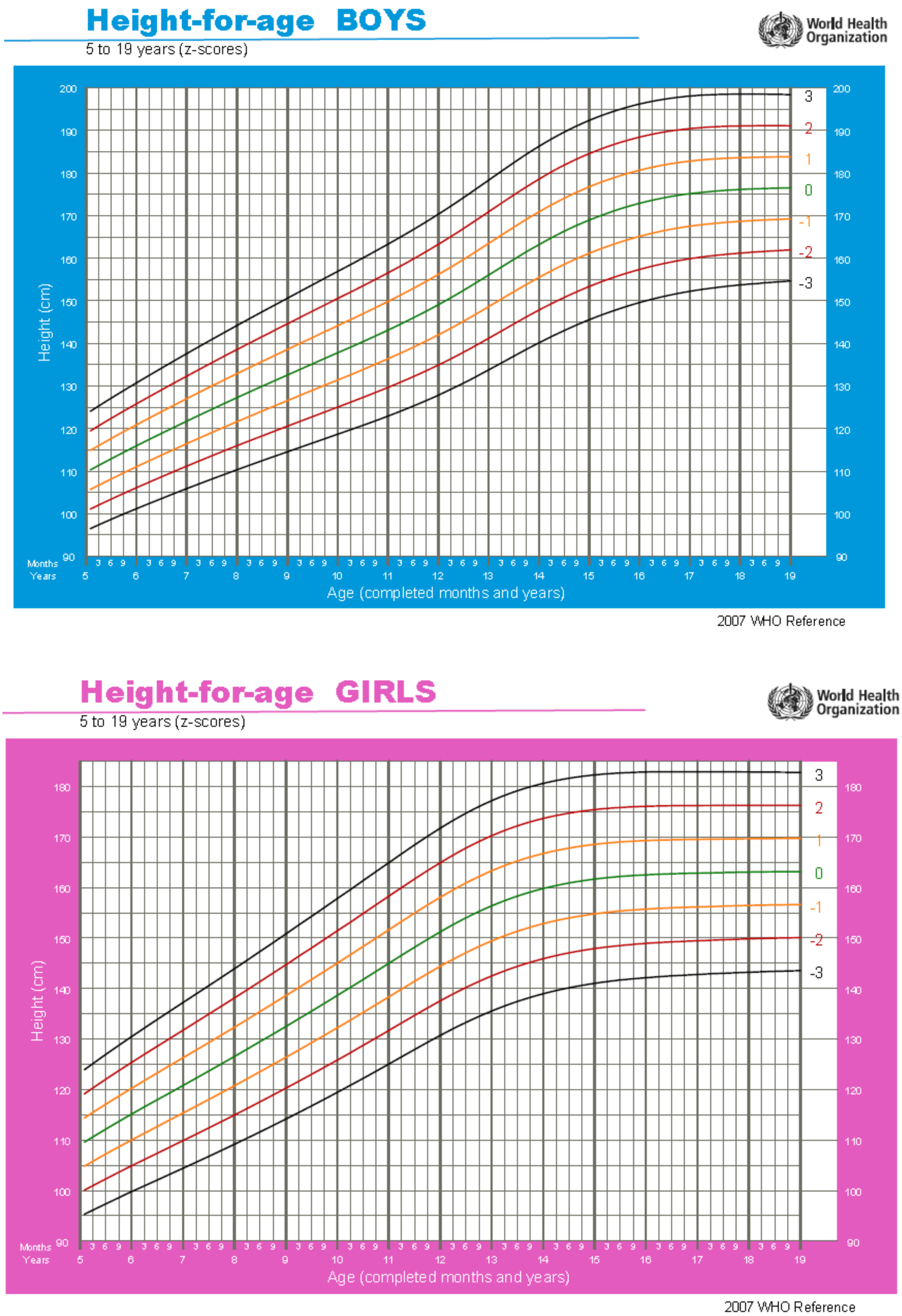
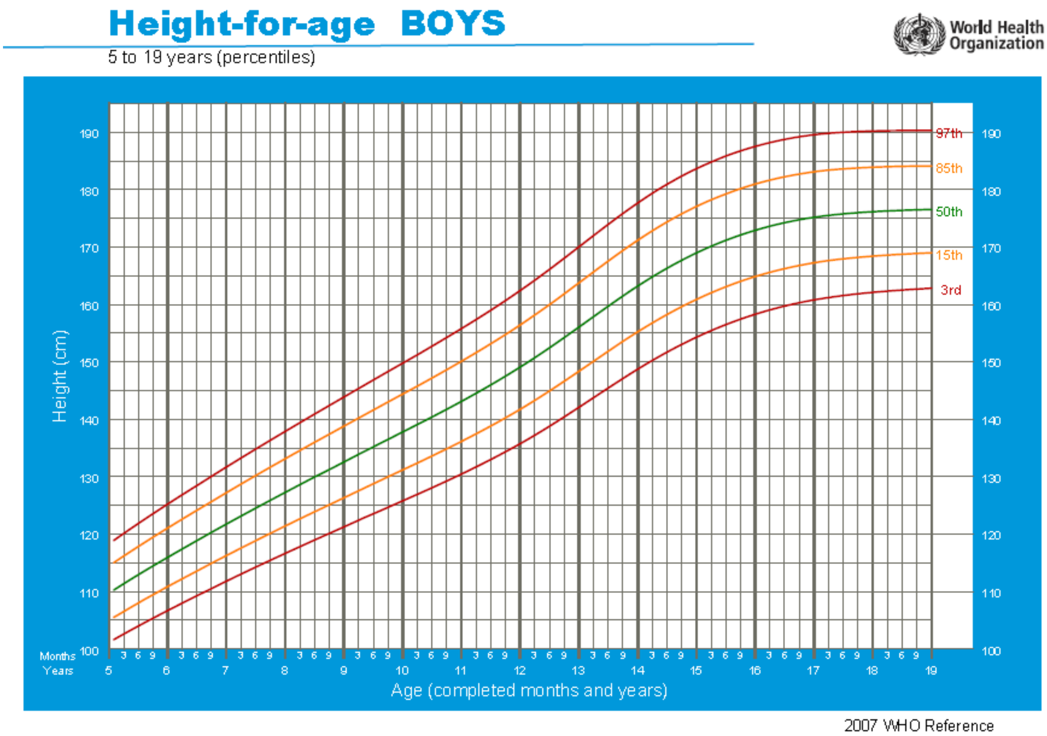


Figure 2-2: BMI for age (z-scores) in boys and girls (WHO, 2007b).



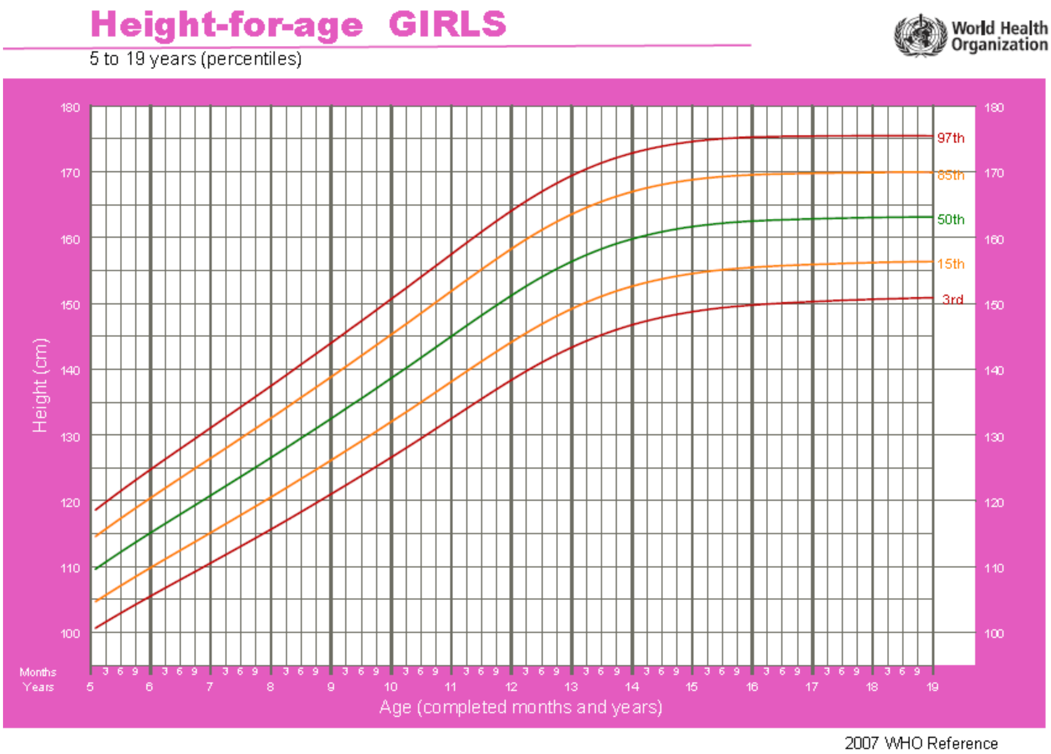
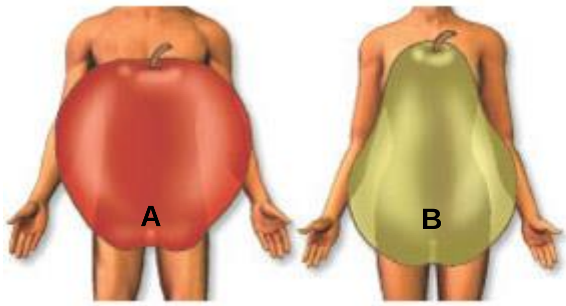


Figure 2-3: BMI for age (percentiles) in boys and girls (WHO, 2007b).

2.3.4 Waist-to-hip ratio

Patterns of body fat distribution are an important predictor of the health risks of obesity (Van Itallie, 1988:143). Waist circumference is an anthropometric measurement used to assess a person's abdominal fat (Whitney & Rolfes, 2008:263). Abdominal fat or obesity (android) provides an increased risk of premature death, coronary artery disease, dyslipidaemia, Type 2 diabetes, metabolic syndrome and hypertension, compared to individuals who demonstrate fat distributed in the hips and thighs (gynoid/gynecoid) (Berger, 2011:27; Folsom *et al*., 1993:485; ACSM, 2010:64). Girth measurements may be used to predict body composition, and different equations are available for different age groups and sexes (Tran & Weltman, 1989:102; Tran & Weltman, 1988:173; ACSM, 2010:65). Abdominal obesity is a concern, thus waist circumference alone can identify if you are at risk (Berger, 2011:27). For waist circumference a horizontal measurement at the narrowest part of your torso just above the navel, but under the rib cage in centimetres is taken (Berger, 2011:28).



Android Gynoid

Figure 2-4: Apple and pear body shape compared (Whitney & Rolfes, 2008:263).

A. Upper-body fat is more common in men than in woman. It is associated with heart disease, stroke, diabetes, hypertension, and some types of cancer (Figure 2-4).
B. Lower-body fat is more common in woman than in men. It is associated with chronic diseases (Figure 2-4).

Hip circumference is taken as a horizontal measurement at the maximal circumference of the proximal thigh (ACSM, 2010:65). When determining body fat distribution waist-to-hip ratio is used, which is the circumference of the waist divided by the circumference of the hips (ACSM, 2010:64; Bray & Gray, 1988:440) (Table 2-2).

$$\text{WHR} = \frac{\text{Waist circumference (cm)}}{\text{Hip circumference (cm)}}$$

Table 2-2: Interpretation of waist circumference for adults (Bray, 2004:348; ACSM, 2010:66).

	Waist circumference (in inches and centimetres)	
Risk category	**Men**	**Women**
Very low	Less than 31.5 in. (80 cm)	Less than 27.5 in. (70 cm)
Low	31.5 - 39.0 in. (80 - 99 cm)	27.5 - 35 in. (70 - 89 cm)
High	39.5 - 47.0 in. (100 - 120 cm)	35.5 - 43.0 in. (90 - 109 cm)
Very high	Greater than 47.0 in. (120 cm)	Greater than 43.0 in. (110 cm)

2.3.5 Skinfolds

Skinfold measurements used to determine body composition correlate very well (r = 0.70-0.09) with body composition determined by hydro densitometry (Roche, 1996:167). The principle is that the amount of subcutaneous fat is proportional to the total amount of body fat, but the exact proportion of subcutaneous-to-total fat varies with sex, age, and ethnicity (ACSM, 2010:66; Roche, 1996:167). Assuming that the appropriate techniques and equations are used, the accuracy of predicting percent body fat from skinfolds is ±3.5% (ACSM, 2010:66). When a population-specific equation is needed, Heyward and Stolarczyk provide a reference to match client and equation based on sport, fatness, ethnicity, age, and sex (ACSM, 2010:66; Heyward & Stolarczyk, 1996:12). A few factors that could cause measurement errors in skinfold assessment include inexperienced evaluator, poor technique, an extremely obese or lean subject, or improperly calibrated callipers (ACSM, 2010:68; Heyward, 1998:285).

There are other methods to measure percentage body fat, such as underwater (hydro densitometry) weighing, Plethysmography (air displacement), bio-electric impedance, and energy x-ray absorptiometry (DEXA). The reason these methods are not used is that they are not cost efficient, which proves very expensive, especially when testing large population groups (ACSM, 2010:69-70).

2.4 PREVALENCE OF OBESITY

2.4.1 Introduction

Obesity and overweight is a worldwide epidemic in both children and adolescents as well as adults, and is the fifth leading risk for global deaths (WHO, 2013:311). In 2008 more than 1.8 billion adults, 20 years and older, were overweight and of these, over 200 million men and nearly 300 million women were obese. This previous statistic also shows that 35% of adults aged 20 and older were overweight in 2008, and 11% were obese. Of these statistics 40 million children under the age of five were overweight in 2011 (WHO, 2013:311). Statistics in 2000 also clearly proved that obesity in children and adolescents had increased drastically in developing countries (WHO, 2000:265).

2.4.2 Prevalence of obesity worldwide

Childhood obesity has already reached pandemic proportions globally (De Ridder *et al*., 2012:1022). Cameron (2005:54) stated that in 2001, 15% of the United Kingdom's 15-year old children were obese, with a further 20% overweight. It was also recorded that almost 20% of children and adolescents in the United States of America are obese (Wang *et al*., 2002:974). In addition 30% of girls and 10% of boys who were obese continued to be obese in adulthood, resulting in an abnormal prevalence of dyslipidaemia, hypertension, and insulin resistance (Goedecke *et al*., 2006:67).

According to a report by Ogden *et al.* (2008:2403) in a sample of US children collected between 2003 and 2006 using cut-off values similar to those of the WITO, the prevalence of overweight (BMI > 85th percentile) and obesity (BMI > 97th percentiles) in children 2-19 years of age was 31.9% and 11.9%, respectively. A report from Mexico of a sample group of 10-to-17-year-old children collected in the year 2000, showed a higher prevalence of excess weight in girls than in boys with 14.3-19.1% vs 10.8-16%, respectively (Del Rio-Navarro *et al*., 2004:220). The prevalence of excess weight was higher in Saudi children with 25.1% vs 24.7% in girls and boys (Mohammed *et al*., 2010:206). The overall pattern of gender variation in the prevalence of overweight and obesity between the age of 15-18 years, clearly indicates a higher prevalence of overweight in girls, and this pattern is consistent in Mexico, the UAE and Saudi Arabia (Del Rio-Navarro *et al*., 2004:220; Malik & Bakir, 2007:18; Al-Almaie, 2005:609). In 1998 a sample of German children and adolescents showed BMI values higher than published French, similar to British and Swedish, but lower than Italian and North American reference data (Schaefer *et al*., 1998:468). There is also an increase in the prevalence of obesity in Brazilian adolescents: Romero *et al*. (2014:273) found that (44.2%) of the Brazilian population was overweight/obese.

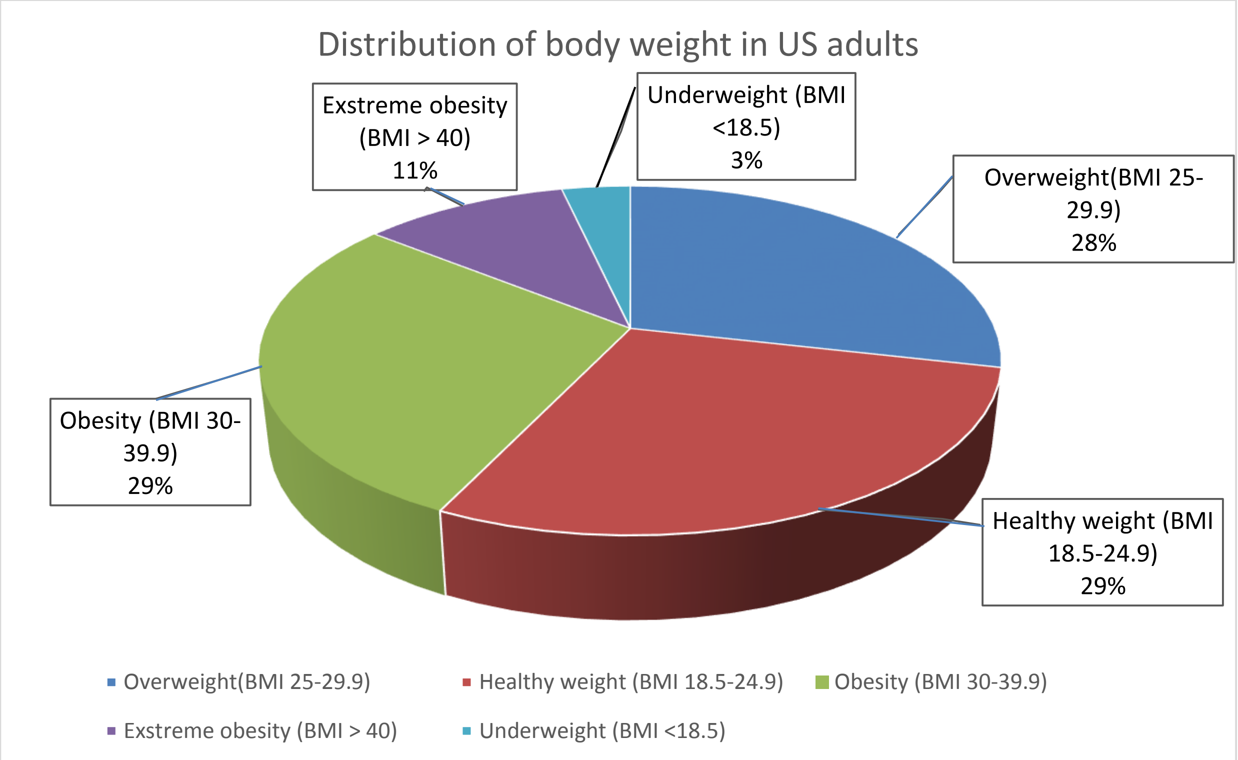


Figure 2-5: Distribution of body weight in US adults (Whitney & Rolfes, 2008:260).

2.4.3 Prevalence of obesity in Africa

Overweight and obesity is increasing in most countries across the world (WHO, 2000; Adamo *et al*., 2010:226) and the rates of obesity have tripled in those developing countries which have adapted a Western lifestyle (Hossain *et al*., 2007:213; Adamo *et al*., 2010:226). It is clear that child overweight and obesity is on the rise and is causing an increase in public health problems in countries like East Africa (Adamo *et al*., 2010:226). Overweight and obesity are now on the increase in low- and middle-income populations, particularly in urban areas. In 2010 globally, 43 million children under the age of 5 years were overweight, and of this 35 million were living in developing countries (De Onis *et al*., 2010:1257; Rossouw *et al*., 2012:1). Since 1990 to 2010 the number of overweight and obesity growth rates has doubled, and research shows that Africa has the fastest overweight and obesity growth rates (De Onis *et al*., 2010:1259; Rossouw *et al*., 2012:1). The two main causes of overweight and obesity in developing countries are a decline in physical activities, and diets rich in refined fats, oils and carbohydrates (Boutayeb & Boutayeb, 2005:2; Prentice, 2005: 98; Rossouw *et al*., 2012:1). Undernutrition and communicable diseases were once the overriding health threat in developing countries; it is now estimated that non-communicable diseases, such as obesity-associated disorders, could be the cause of 7 out of every 10 deaths by 2020 (Boutayeb & Boutayeb, 2005:2; Prentice, 2005:98; Rossouw *et al*., 2012:1).

2.4.4 Prevalence of obesity in South Africa

In South Africa the occurrence of overweight and obesity in children at present is said to be at least comparable to that found in developed countries more than a decade ago (Truter *et al*., 2010:232; Armstrong *et al*., 2006*a*:442; Rossouw *et al.,* 2012:2). It is clear that, according to recent research, great concern exists regarding the increased epidemic of obesity and physical inactivity among youth. Efforts to remedy this situation should be applied in South Africa as well as many other countries now (De Ridder & Coetzee, 2013:246). It has been pointed out that South Africa is now on par with many industrialised nations, and among the highest levels in Africa (Reddy *et al*., 2008:206; Rossouw *et al*., 2012:2).

A comparison over the period from 1994-2004 between rates from the South African Primary Schools anthropometric survey and the health of the Nation Study showed an increase in overweight from ±1.2% to ± 13%, and in obesity from ± .02% to ± 3.3% (Armstrong *et al*., 2011:835). In rural communities from the Limpopo, Eastern Cape and Kwa-Zulu Natal (rural areas), a very high overweight and obesity rate was observed (up to 50% of < one-year-olds being overweight or obese) (Smuts *et al*., 2008:123; Mamabolo *et al*., 2005:502; Rossouw *et al*., 2012:2). According to Mamabolo *et al.* (2005:506), overweight and obesity can be related to certain cultural beliefs which hold that a fat infant is a healthy infant, thus mothers tend to overfeed the infants. The majority of all recent literature on children and adolescents in South Africa, indicated that a higher prevalence of overweight and obesity was found in girls than in boys (Truter *et al*., 2010; Armstrong *et al*., 2006*b:60*; Reddy *et al*., 2008; Somers, 2004; Makuddem-Peterson & Kruger, 2004; Cameron & Getz, 1997 and Jinabhai *et al*., 2003).

There are different factors that play a role in this gender disparity, such as the level of physical activity, possible differences in the energy needs between boys and girls, in behavioural or cultural phenomena, as well as the timing of sexual maturation (Kimani-Murage *et al.*, 2010:158; Rossouw *et al.,* 2012:2). A phenomenon was observed by Armstrong *et al.* (2006*b*:62) that may be culture-related and that is that overweight increased with age in African girls and decreased with age in white girls. It has been speculated that overweight in certain African cultures is seen as an indication of happiness and wealth, and also an indication that the individual does not have HIV or AIDS (Mvo *et al*., 1999:29; Clark *et al*., 1999:736). Although there are indications of higher rates of overweight and obesity in South African children in urban areas, a lot more studies are needed to confirm these indications (Labadarios *et al*., 2005:533; Steyn *et al*., 2005:10).

2.4.5 Do overweight children stay overweight?

All studies which examined the persistence (tracking) of fatness from childhood up until adolescence to adulthood concluded that fatter children were more likely to be obese later in life as adults (figure 2-6). From this it is evident that 2% of the fattest adolescents from 11-16 years have a very high risk of obesity in adulthood (Powers *et al*., 1997:511). Overweight and obesity during childhood and adolescence influence wellbeing during this stage of life and can persist into adulthood (Rossouw *et al*., 2012:2). Reilly and Kelly (2010:158) stated that excess body fat during childhood and adolescence increases the overall risk for the development of medical conditions during adulthood, including the following: insulin-resistance; adult-onset Type 2 diabetes mellitus, and cardiovascular problems such as hypertension, ischaemic heart disease, and stroke (Reilly & Kelly, 2010:158; Steinberger & Daniëls, 2003:1451; Rossouw *et al*., 2012:2). A recent systematic review of the literature indicated that overweight and obesity in childhood and adolescence increases the risk in adulthood for premature mortality, disability pension and morbidity (Reilly & Kelly, 2010:158; Rossouw *et al*., 2012:3).

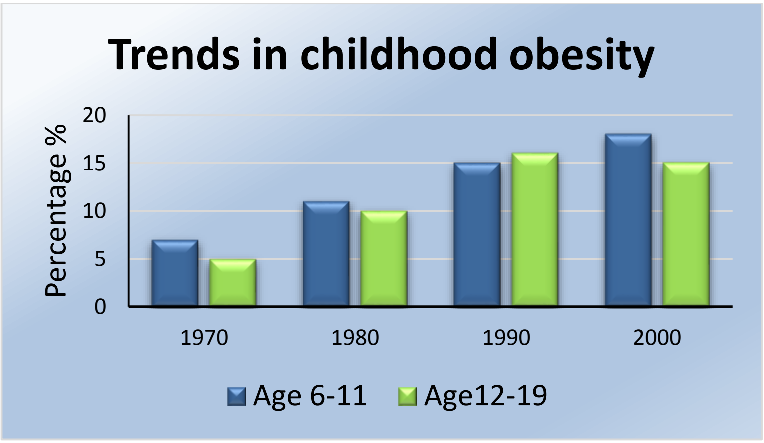


Figure 2-6: Trends in childhood obesity in the US (Whitney & Rolfes, 2008:567).

2.5 HEALTH RISKS OF OBESITY

2.5.1 Introduction

Overweight and obesity have a negative impact on both the physical and psychological levels of wellbeing during childhood and adolescence. From a physical point of view, there is an increase in a number of cardiovascular abnormalities as well as the risk of Type 2 diabetes mellitus during childhood and adolescence (Steinberger & Daniëls, 2003:1451). Most of the major risk factors (that aren't usually seen in children and adolescents) include high systolic and diastolic blood pressure, dyslipidaemia (increased low-density lipoprotein cholesterol, raised triglycerides, and low levels of high-density lipoprotein cholesterol), abnormal left ventricular function, abnormal vascular endothelial function, and atherosclerotic lesions (Lee, 2007:81; Hannon *et al*., 2004:476; Rossouw *et al*., 2012:1). Most cases of childhood obesity used to be associated with Type 1 diabetes mellitus, but there has over the last couple of decades been a rapid increase in the development of obesity-associated Type 2 diabetes mellitus (Hannon *et al*., 2004:476). In obese children symptoms of the insulin resistance syndrome which are not uncommon include: hyperinsulin ageing, dyslipidaemia, and hypertension (Steinberger & Daniëls, 2003:1450).

Other uncommon conditions found in association with overweight and obesity in children and adolescents, include developing asthma, or an increase in the severity of existing asthma, obstructive sleep apnoea, low-grade systemic inflammation, early onset of puberty, fatty liver disease, foot and other skeletal abnormalities (Lee, 2007:81; He & Karlsberg, 2001:247; Reilly & Kelly, 2010:158). According to a recent study, the risk of developing metabolic disease (estimated from central obesity-waist circumference), was 1% for boys and approximately 16% for girls (Kimani-Murage *et al.*, 2010:158). There exist a few studies and reports on the high prevalence of hypertension in children and adolescents, however, unfortunately very few investigate the link between overweight/obesity and hypertension (Monyeki *et al.,* 2006:118; Makgae *et al*., 2007:241). Even though hypertension rates as high as 22% were found in overweight children, and 35% in obese children, hypertension was also found in up to 25% of normal weight children (Goedecke *et al*., 2006:65).

When referring to overweight or excessive body fat, there are so many health risks that it has been designated a disease: obesity (Whitney & Rolfes, 2008:265) (figure 2-7). Among some of the health risks associated with obesity are cardiovascular disease, diabetes, hypertension, gall bladder disease, kidney stones, sleep apnoea, abnormal cases of breathing problems (including Pickwickian syndrome, a breathing blockage linked with sudden death), and complications in pregnancy and surgery (Whitney & Rolfes, 2008:265). Each year, obesity-related illnesses cost South Africa billions of dollars; as much as the medical costs of smoking (Finkelstein *et al*, 2003:265; Whitney & Rolfes, 2008:265). In terms of lives, the cost is also great: each year an estimated 300 000 people die from obesity related diseases. Obesity is second only to tobacco in causing preventable illnesses and premature deaths. As excess weight increases, mortality increases; people with a BMI greater than 35 are more than twice as likely to die prematurely as those with a much lower BMI (Flegal *et al*., 2005:1865).

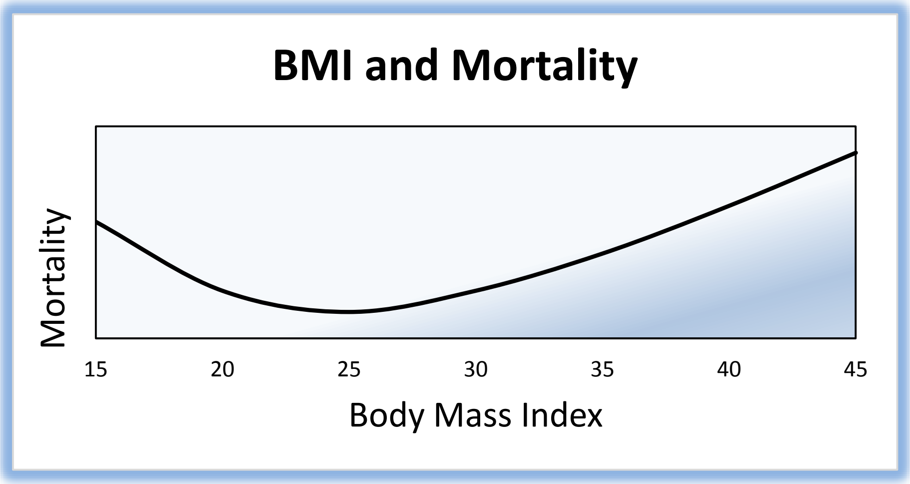


Figure 2-7: BMI and mortality (Whitney & Rolfes, 2008:264).

Both central obesity and weight gains of more than 9 kilograms between early and middle adulthood are correlated with increased disease risk (Shienkiewitz, 2006:430) (Figure 2-7).

2.5.2 Cardiovascular disease

The relationship between obesity and cardiovascular disease is strong with links to both elevated blood cholesterol and hypertension. The risk of heart attack and stroke may be raised by central obesity, almost as much as the three leading risk factors (high LDL cholesterol, hypertension, and smoking) do. A few cardiovascular disease risk factors associated with obesity include: high blood pressure (hypertension) and diabetes. Weight gain also increases the risk of cardiovascular disease. Weight loss on the other hand, can effectively lower both blood cholesterol and blood pressure in obese people (Whitney & Rolfs, 2008:265).

2.5.3 Diabetes

Most overweight or obese adults have Type 2 diabetes (Whitney & Rolfs, 2008:265). Type 2 diabetes is often associated with central obesity, and central body-fat cells appear to be larger and more insulin-resistant than lower-fat cells (Livingston, 2006:366). Body weight and weight gains also influence diabetes. An average weight gain of more than 4.5 kilograms per annum after the age of 18, double the risk of developing diabetes. And conversely, weight loss improves glucose tolerance and insulin resistance (Reaven, 2005:403; Klein, 2004:260).

2.5.4 Cancer

The relationship between the risk of cancer and body weight (weight gain) increases, but is not fully understood by researchers yet (Bray, 2002:3453). A possible explanation may be that obese people have elevated levels of hormones that could influence cancer development (Bray, 2002:3453). The major site of oestrogen synthesis in woman is in the adipose tissue. Obese woman have elevated levels of oestrogen, and oestrogen has been implicated in the development of cancer of the female reproductive system; a cancer that accounts for half of all cancers in woman (Whitney & Rolfs, 2008:266).

2.5.5 Inflammation and the metabolic syndrome

Obesity is accomplished by chronic inflammation, and inflammation contributes to chronic disease (De Caterina, 2006:4249). Lipids first fill the adipose tissue and then migrate into other tissue such as the muscle and liver; this all happens as a person grows fatter (Hansen *et al*., 2006:481). The body's metabolism is changed as soon as fat accumulates in the abdominal region, resulting in insulin resistance, low HDL, high triglycerides, and high blood pressure (De Caterina, 2006:4260). Collectively these symptoms are known as metabolic diseases which increase the risk of diabetes, hypertension, and atherosclerosis. Genes are activated during fat accumulation (especially in the abdominal region where genes are signalling codes for proteins involved in inflammation (Trayhurn *et al*., 2006:1937). It is important to know that proteins released from adipose tissue signal changes in the body's fat and energy status and are called adipokines. More than 50 adipokines are identified, some of which play a role in inflammation (Whitney & Rolfs, 2008:265). An increase in blood lipids – whether due to obesity or to a high-fat diet – also promotes inflammation (Boden, 2006:180). These factors explain why chronic inflammation accompanies obesity, and how obesity contributes to the metabolic syndrome and the progression of chronic disease (Lau, 2005:H2039).

2.6 RISK FACTORS OF OVERWEIGHT AND OBESITY

2.6.1 Overweight and obesity among children and inactivity as a factor

Over the past 100 years evidence shows a major shift in research towards childhood overweight and obesity, compared to research on children and youth in developing or third-world countries which focused on poverty and malnutrition (Jacobs & De Ridder, 2012:45; Wang *et al*., 2002:974). Chin *et al.* (2012:252) stated that children of today represent the largest cohort group in history, with 2.2 billion children (1.5 billion youth) residing in developing countries (United Nations children's fund, 2005; World Bank, 2007). That said, attention must be given to the prevalence of obesity in children, not only in first-world countries (USA), but also in third-world countries, of which South Africa is one (De Ridder & Coetzee, 2013:242).

During a survey conducted in 2002 in South Africa, it was found that over 17% of all South African adolescents were overweight and 4.2% were obese; the same study also indicated that

17.1% of South African children (aged 1-9) living in urban areas were overweight or obese (Reddy *et al.,* 2008:204*).* Armstrong *et al*. (2006*b*:56) also indicated a prevalence of overweight for 14% for boys and 17.9% for girls, and with regard to obesity, 3.2% for boys, compared with 4.9% for girls among 6-13 year-old group. According to Kemp *et al*. (2011:120) a prevalence of 7.8% overweight and 3.8% obesity in Grade 1 leaners in the North-West province of South Africa was indicated, compared to a study in 2012 on 11-to 13-year-old black children living in rural areas in North-West province, where 5% of the boys were overweight and 4% were obese. With regard to the girls, 10% were overweight and 10% were classified as obese (Jacobs & De Ridder, 2012:48). Thus it is clear that a higher prevalence of overweight and obesity exists in girls (black). In a different study Westwood mentions a strong correlation with obesity in black South African girls (Westwood, 2012:156).

Kahn (2011) reported that only 42% of the youth in his study participated in sufficient vigorous physical activity. The figures are even worse in smaller towns and rural areas, with 64% of girls and 45% of boys reporting little or no moderate physical activity (Healthy Active Kids; South Africa, 2007). This hypokinetic trend might be associated with a sedentary culture, as 25% of adolescents report little or no interest in leisure-time activities, which is of grave concern (Healthy Active Kids; South Africa, 2007). Reddy *et al*. (2003) reported that only 54.3% of adolescents had PE and only 52.8% participated in vigorous physical activity at school. Only 33% of the total time allocated in the learning category of life orientation for Grades 4 to 6 is used for physical development and movement. This trend is frightening because PE is supposed to provide the opportunity for all children to be physically active (Rajput & Van Deventer, 2010:140).

2.6.2 Genetic factors

A remarkable effect on obesity is genetics in an obesogenic environment (Wardel *et al*., 2008:398). The gene associated with fat mass and obesity (FTO) was the first, well-replicated gene to be associated with common obesity in both adults and children from various ethnic backgrounds (Fryling *et al*., 2007:890; Loos & Borchard, 2008:246). Factors inherited by parents may account for up to 70% of body weight differences in individuals. A child of non-obese parents has only a 10% chance of becoming obese or overweight, compared to a child with one obese parent who has a 40% chance, or a child with two obese parents who has an 80% chance of becoming obese or overweight (Kruskall, 2011:266). Research on identical twins provides insight into the importance of genetics in determining body mass and body types. Similar patterns of body fat distribution are seen in identical twins raised apart in spite of different environmental influences (Kruskall, 2011:267). In addition to body mass and body fatness (distribution), people tend to inherit specific body types, such as being tall and thin or short and stout (Kruskall, 2011:267). There are certain factors out of an individual's control, for example, where body fat is deposited. Some people will accumulate body fat in the abdominal area (android), whereas others accumulate fat in their hips and thighs (gynoid), (Kruskall, 2011:267).

2.7 CHAPTER SUMMARY

Obesity during adolescence is a serious condition and is increasing worldwide, especially in developing countries such as South Africa. The population's diet is changing to a more Western life style which is a high-fat energy diet, and adolescents are falling victim to this high-fat diet and as a result, are becoming obese. Furthermore, adolescents are no longer as physically active as they once were, largely due to the unsafe conditions of urban and rural areas which has led to less exercise, which increases the prevalence of obesity among adolescents. The latter also spend a large part of their day watching television and playing computer games, which causes the energy intake to be higher than the energy consumption, and the resultant energy imbalance of this inactivity among adolescents further increases the risk of obesity.

There are many methods to classify obesity, but it is difficult in children because they are still growing and developing. Other factors that influence classification of obesity are gender, race, and age. Obesity carries many psychological disadvantages such as a decrease in self-esteem, depression, and rejection from peers. Obesity also carries health risks such as hypertension, Type 2 diabetes, orthopaedic problems, and many other illnesses.

Body composition is considered by many to mean "level of fatness": it is an important indicator for obesity and can be determined at a young age, offering the opportunity to decrease the risk of overweight and obesity. Body mass, stature, skinfolds, BMI and body fat percentage are all methods used to determine body composition. Research on both African and South African children living in rural areas on the body composition and prevalence rates of overweight/obesity will provide an opportunity to understand the role of development in children and adolescents and the importance thereof. Many studies have suggested that obesity has already reached pandemic proportions globally and if not acted upon now, will only get worse.

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CHAPTER 3: RESEARCH ARTICLE

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Body composition profiles of 14-year-old adolescents attending high schools in Tlokwe municipality area: the PAHL-study

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3.1 Abstract

Childhood overweight and obesity have already reached pandemic proportions globally and both are associated with various health problems. As such, the prevalence of obesity in adolescents is a cause for major concern to health professionals. The purpose of this study therefore, was to determine the status of body composition and the effect of gender, age, and race on body composition. A total of 280 learners (109 boys and 171 girls) aged 14 years who are part of the on-going Physical Activity and Health Longitudinal Study (PAHLS) from the Tlokwe Local Municipality are participants in this study. Body mass, stature and skinfolds were measured according to standard procedures described by International Society for the Advancement of Kinanthropometry (ISAK) and subsequently were used to determine body composition (i.e. percentage body fat, sum of skinfolds, body mass index and waist-to-height ratio) of the participants. All data was analysed using SPSS Version 21.0. The statistical level was set at p-value ≤0.05. The results indicated that out of the total group 13.1 % were overweight, 29.1 % normal weight and 57.8 % underweight. When boys and girls were compared, boys had an overweight percentage of 9.1 % compared to the girls 15.7 %. When the data was further analysed separately for Black and Caucasian, the results showed that black girls had a relatively high overweight (15.8 %) compared to their Caucasian counterparts (15.4 %). As for the impact of gender, age and race on body composition (using linear regression analysis) results show significant gender, age, and race independent effects on body composition of BMI. The results also showed no significant ($p \geq 0.05$) age independent effect on body composition measures of percentage body fat, sum of two skinfolds, fat free mass and waist-to-height ratio. In conclusion overweight is a huge problem among adolescents, especially girls.

Keywords:
Body Composition, Underweight, Overweight, Obesity, Adolescents, Children.

3.2 Introduction

Research shows that obesity or overweight is a worldwide epidemic in children and adolescents as well as adults, and it is also the fifth leading risk for global deaths (WHO, 2013). Body composition can help researchers to determine the different classes of obesity or overweight in children, adolescents and adults (De Ridder *et al.*, *2012).* Body composition is considered to mean the "level of fatness", but the definition is a lot wider than that; it is also defined as being, "the chemical or physical components that collectively make up an organism's mass (Stewart, 2010)". It is clear that by using body composition we can determine a child, adolescent or adult's level of fatness (class of obesity).

In a review study by De Ridder *et al.* (2012) it was indicated that worldwide statistics showed that childhood obesity has already reached pandemic proportions. Overweight and obesity is increasing in most countries across the world (WHO, 2000; Adamo *et al.*, 2010) and the rates of obesity have tripled in developing countries due to the adoption of a Western lifestyle (Hassain *et al.*, 2002; Adamo *et al.*, 2010). It was also researched that almost 20% of children and adolescents in the United States of America were obese in 2002 (Wang *et al.*, 2002). With regard to South Africa, 30% of girls and 10% of boys were obese and continued to be obese in adulthood (Goedecke *et al.*, 2006). In Mexico a sample group of 10- to 17-year-old children was studied and results showed a higher prevalence of excess weight in girls than in boys (girls 14.3% - 19.1% vs. boys 10.8% - 16% respectively) (Del Rio-Navarro *et al.*, 2004). In Saudi children's obesity levels were higher in girls (25.1%) vs. boys (24.7%) (Mohammed *et al.*, 2010). Abound literature showed an overall pattern of gender variation in the prevalence of overweight and obesity, the prevalence of overweight in girls is higher, and this pattern is consistent in Mexico, UAE and Saudi Arabia children (Del Rio-Navarro *et al.*, 2004; Malik & Bakir, 2007; Al-Almaie, 2005).

Reports have shown that overweight and obesity are now on the increase in low- and middle-income populations (such as Africa), particularly in urban areas. From 1990 to 2010 the number of overweight and obesity growth rates has doubled, thus indicating that Africa has the fastest overweight and obesity growth rates (De Onis *et al.*, 2010; Rossouw *et al.*, 2012). The two main causes of overweight and obesity in developing countries are a decline in physical activity, and diets rich in refined fats, oils and carbohydrates (Boutayeb & Boutayeb, 2005; Prentice, 2005; Rossouw *et al.*, 2012).

In South Africa the occurrence of overweight and obesity in children at present is said to be at least comparable to that found in developed countries more than a decade ago (Truter *et al.*, 2010; Armstrong *et al.*, 2006; Rossouw *et al.,* 2012). Some have also stated that it was on par with many industrialised nations and among the highest in Africa (Reddy *et al.*, 2008; Rossouw *et al.*, 2012). The majority of all recent literature on children and adolescents in South Africa has indicated that a higher prevalence of overweight and obesity was found in girls than in boys (Truter *et al.*, 2010; Armstrong *et al.*, 2006; Reddy *et al.*, 2008; Somers, 2004; Makuddem-Peterson & Kruger, 2004; Cameron & Getz, 1997; Jinabhai *et al.*, 2003). There are different factors that play a role in this gender disparity, such as the level of physical activity, possible differences in the energy needs between boys and girls in behaviour or cultural phenomena, and also in the timing of sexual maturation (Kimani-Murage *et al.*, 2010; Rossouw *et al.,* 2012). According to the literature it is clear that there is a major problem with obesity/overweight in children and adolescents. The purpose of this study was to determine body composition profiles of adolescent boys and girls residing in Tlokwe Local Municipality and the effect of gender, age, and race on body composition.

3.3 Research Methods

3.3.1 Participants

A total of 280 learners (109 boys and 171 girls) who were part of a larger longitudinal study, the Physical Activity and Health Longitudinal Study (PAHLS), which is an observational multidisciplinary study (Monyeki *et al*., 2012) participated in this study. The general objective of PAHLS is to describe the development of physical activity and the determinants of health risk factors of health behaviour, sport determinants and recreational activities in 14-year-old adolescents attending high schools in the Tlokwe area of the North West Province in South Africa, followed over a five-year period. For purposes of the current study, a cross- sectional experimental research design was used in which the data from the 2010 sample was utilized.

More details about the study have been described elsewhere (Monyeki *et al*., 2012). The study was approved by the Ethics Committee of the North-West University (NWU-0058-01-A1) and by the District Director of the Potchefstroom Department of Basic Education.

3.3.2 Measuring instruments

Anthropometric variables
The following anthropometric variables were measured according to the protocols of The International Society for the Advancement of Kinanthropometry (ISAK) (Stewart *et al*., 2011).

Body mass; the measurement was taken with a portable electronic scale, (Beurer Ps07 Electronic Scale, Ulm, Germany) to the nearest 0.1 kg.

Stature; a Harpenden portable stadiometer (Holtain Limited, U.K.) with a perpendicular board was used to take this measurement to the nearest 0.1 cm.

Skinfolds; triceps and subscapular skinfolds were taken with a Harpenden skinfold calliper (Holtain Limited, U.K.) with a constant pressure of $10g/mm^2$ to the nearest 0.2 mm.

Waist circumference; was taken with a Lufkin anthropometric tape (Cooper Industries, U.S.A.) to the nearest 0.1 cm. Subsequently, waist-to-height ratio (WHtHR) was calculated from waist divided by height.

Body mass index (BMI); as a measure of body composition was calculated as body mass/$stature^2$ (kg/m^2). Subsequently, normal weight and overweight/obesity as well as underweight/thinness were classified according to the age- and sex-specific cut-off points for children according to Cole *et al.* (2000) and Cole *et al.* (2007) respectively.

Percentage body fat (%BF); also as a measure of body composition was based on the sum of triceps and calf skinfolds derived from skinfolds using the equation developed by Slaughter *et al.* (1988), which is internationally accepted for use in children and adolescents from different ethnic groups. Percentage body fat to be compared according to Lohman *et al.* (2000) three classification, namely; very low (7 - 11), low (12 - 14), optimal range (15 - 18), moderate high (19 - 25), high (26 - 32), and very high (32 and above). All anthropometric measurements were taken twice by Level 2 ISAK-certified anthropometrists and the average scores of the two measurements were used.

3.3.3 Statistical Analyses

All data analyses were performed with Statistical Package for the Social Sciences (SPSS), Version 21.0 program (SPSS Inc., 2012). Descriptive statistics of means, minimum, maximum, standard deviations, frequencies for body composition variables were computed. After the computation of the descriptive analyses, independent *t*-test and Mann-Whitney *U*-test were calculated to test differences with respect to statistical significance. Linear regression analyses were performed in order to test the effect of gender, age, and race on body composition. The statistical level was set at p-value ≤0.05.

3.4 Results

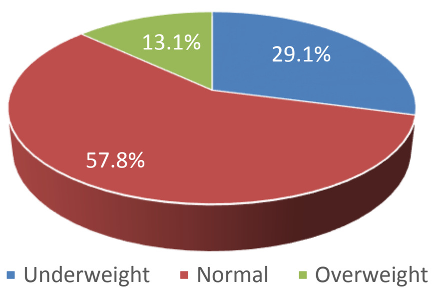

Figure 1: BMI categories for the total group

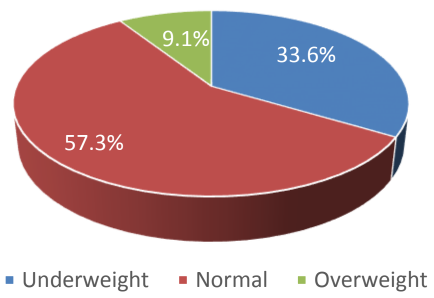

Figure 2: BMI categories for the total boys group

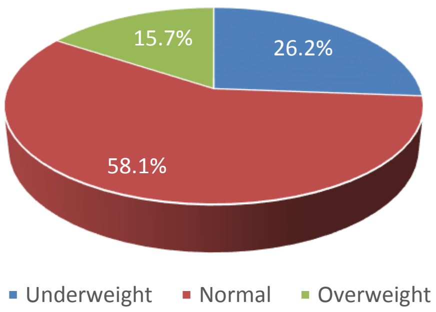

Figure 3: BMI categories for the total girls group

The BMI categories for the total group (Figure 1), show that out of the total of 280 learners, 13.1% were overweight, 29.1% normal weight and 57.8% underweight. It is important to understand that only 29.1% achieved a normal score for BMI. Figure 2 depicts BMI categories for the total boys group. The results show that out of the total of 109 boys, 9.1 % were overweight, 57.3 % normal weight and 33.6 % underweight. It is clearly noted that a low percentage of boys are categorised as overweight. Figure 3 presents the total girls group BMI's categories and the results show that out of the total of 117 girls, 15.7 % were overweight, 58.1 % normal weight and 26.2 % underweight. A higher percentage of girls were categorised as overweight.

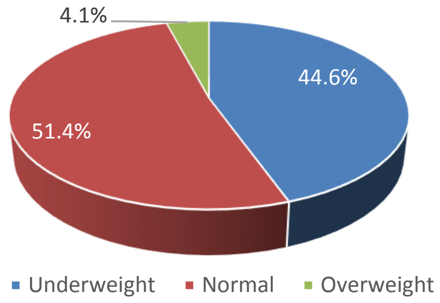

Figure 4: BMI categories for the total black boys group

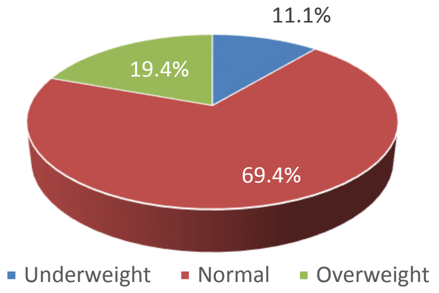

Figure 5: BMI categories for the total white boys group

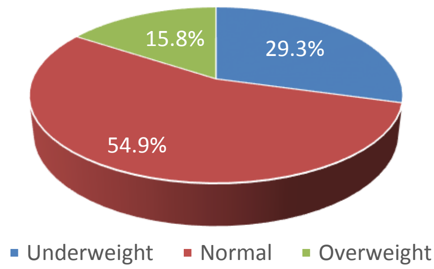

Figure 6: BMI categories for the total black girls group

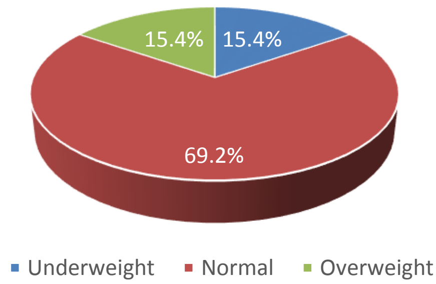

Figure 7: BMI categories for the total white girls group

Figure 4 presents the BMI categories for the total group of black boys. According to the results, out of the total group of black boys (75), 4.1 % were overweight, 51.4 % normal weight and 44.6 % underweight. The BMI categories for the total group of white boys (Figure 5), shows that out of the total of 36, 19.4 % were overweight, 69.4 % normal weight and 11.1 % underweight. When compared to the girls groups in Figures 6 and 7 the results indicate that 15.8% of black girls were overweight, 54.9% normal weight and 29.3% underweight. (Figure 6 presents the BMI categories for the total group of black girls (135) while Figure 7 presents the BMI categories for the total group of white girls.) The results for the latter show that out of the total of 40, 15.4 % were overweight, 69.2 % normal weight and 15.4 % underweight.

Table 1 presents the descriptive statistics of means, minimum, maximum, p-values of the total participants in the study (all boys and girls). There were no significant ($p=0.82$) age differences between boys and girls. Boys were significantly ($p<0.001$) taller (165.40±9.55) compared to their female (157.89±6.95) counterparts. Girls' percentage body fat was significantly ($p<0.001$) larger (mean =26.01±8.51; and maximum of 54.47) than that of the boys (mean of 13.19±8.56; and maximum of 46.86). There was a significant difference in the sum of skinfolds between boys and girls with boys having a mean of 18.81 (SD = 9.49), and girls a mean of 31.54 (SD = 14.20). There was also a significant difference in WHtHR; boys (mean = 0.41±0.04) vs. girls (mean = 0.43±0.05).

Table 1: Descriptive statistics for the total group of boys and girls

	Gender (1=Male; 2=Female)	N	Minimum	Maximum	Mean	SD	P-Value
Age	1	109			14.90	0.72	0.82
	2	171			14.88	0.82	
Stature	1	111	139.60	192.30	165.41	9.55	0.00
	2	173	140.40	176.50	157.89	6.95	
Body Mass	1	111	30.30	110.30	55.30	13.77	0.32
	2	173	21.00	107.10	53.71	12.86	
%BF	1	111	3.60	46.86	13.19	8.56	
	2	173	12.79	54.47	26.01	8.51	0.00
∑SSK	1	111	9.20	57.80	18.81	9.49	
	2	173	13.20	82.00	31.54	14.20	0.00
BMI	1	111	13.91	38.65	20.01	3.71	
	2	173	8.22	36.46	21.44	4.37	0.00
WHtHR	1	111	0.35	0.63	0.41	0.04	
	2	173	0.34	0.62	0.43	0.05	0.00

BMI = Body Mass Index; %BF = Percentage body fat; SSK = Sum of Skinfolds; FF = Fat Free mass; WHtHR = Waist-to-height-ratio

Table 2 presents the descriptive statistics of means, standard deviation, and p-values of the black boys and girls of the total participants in the study. There were no significant ($p = 0.95$) age differences between boys and girls. Boys were significantly ($p = 0.00$) taller (mean = 161.60 $\pm$ 7.49) compared to their female (mean = 156.11 $\pm$ 6.26) counterparts. There was a significant ($p<0,001$) fat % difference between boys (mean = 10.89 $\pm$ 7.03), and girls (mean = 25.62 $\pm$ 8.78). Boys ∑SKF significant ($p < 0,001$) (mean = 16.69$\pm$ 7.85) compared to their female (mean = 31.00 $\pm$ 14.61) counterparts. Girls body mass index was significantly ($p < 0,001$) larger (mean = 21.21 $\pm$ 4.20) than that of the boys (mean = 18.95 $\pm$ 2.90). The difference between black boys and girls WHtHR shows a significant difference; boys (mean = 0.40$\pm$ 0.04) vs girls (mean = 0.43 $\pm$ 0.10).

Table 2: Descriptive statistics for black boys and girls

	Gender (1=Male; 2=Female)	N	Mean	SD	P-Value
Age	1	73	14.96	0.69	0.95
	2	131	14.95	0.88	
Stature	1	75	161.60	7.49	0.00
	2	133	156.11	6.26	
Body mass	1	75	66.86	13.95	0.04
	2	133	59.88	15.02	
%BF	1	75	10.89	7.03	0.00
	2	133	25.62	8.78	
∑SSK	1	75	16.67	7.85	0.00
	2	133	31.00	14.61	
BMI	1	75	18.95	2.90	0.00
	2	133	21.21	4.20	
FF	1	75	5.88	5.49	0.00
	2	133	14.13	8.38	
WHtHR	1	75	0.40	0.04	0.00
	2	133	0.43	0.05	

BMI = Body Mass Index; %BF = Percentage body fat; SSK = Sum of Skinfolds; FF = Fat Free mass; WHtHR = Waist-to-height-ratio

Table 3 presents the descriptive statistics of means, standard deviation, and p-values of the white boys and girls of the total participants in the study. There were no significant ($p = 0.37$) age differences between boys and girls. Boys were significantly ($p < 0.001$) taller (mean = 173.34 $\pm$ 8.48) compared to their female (mean = 163.81 $\pm$ 5.81) counterparts. Girls' percentage body fat was significantly ($p < 0.001$) larger (mean = 27.28 $\pm$ 7.50) than that of the boys (mean = 17.98 $\pm$ 9.53). Boys ∑SKF significant ($p < 0.001$) (mean = 23.23 $\pm$ 11.10) compared to their female (mean = 33.34 $\pm$ 12.73) counterparts. There was a significant difference in white boys and girls body mass with white boys mass being higher (mean = 66.86 $\pm$ 13.95) vs girls body mass (mean = 59.88 $\pm$ 15.02).

Table 3: Descriptive statistics for white boys and girls

	Gender (1=Male; 2=Female)	N	Mean	SD	P-Value
Age	1	36	14.80	0.79	0.37
	2	40	14.67	0.55	
Stature	1	36	173.34	8.48	0.00
	2	40	163.81	5.81	
Body Mass	1	36	66.86	13.95	0.04
	2	40	59.88	15.02	
%BF	1	36	17.98	9.53	
	2	40	27.28	7.50	0.00
∑SSK	1	36	23.23	11.09	
	2	40	33.34	12.73	0.00
BMI	1	36	22.21	4.25	
	2	40	22.19	4.86	0.72
FF	1	36	13.01	10.09	
	2	40	17.24	9.34	0.00
WHtHR	1	36	0.43	0.05	
	2	40	0.43	0.05	0.55

BMI = Body Mass Index; %BF = Percentage body fat; SSK = Sum of Skinfolds; FF = Fat Free mass; WHtHR = Waist-to-height-ratio

Table 4 explains the impact of gender, age, and race on body composition, which was tested by using linear regression analyses. The results show significant ($p<0.001$; $p<0.05$) gender, age and race independent effects on body composition of BMI. In addition, the results show no significant ($p>0.05$) age independent effect on body composition measures of %BF, SSKF, fat free mass and WHtR.

Table 4: Impact of gender, age and race on body composition (linear regression analyses)

	Regression coefficient B	***Significance***	***95.0% Confidence Interval for B***	
BMI				
Gender	1.608	0.001	0.635	2.581
Age	0.768	0.013	0.163	1.374
Race (black, white)	2.106	<0.0001	1.031	3.181
%BF				
Gender	13.261	<0.000	11.232	15.29
Age	0.9	0.162	-0.362	2.163
Race (black, white)	4.153	<0.0001	1.911	6.395
SSK				
Gender	13.248	<0.0001	10.22	16.276
Age	1.246	0.194	-0.638	3.131
Race (black, white)	4.329	0.011	0.983	7.676
FF				
Gender	7.164	<.0001	5.184	9.144
Age	1.134	0.071	-0.098	2.366
Race (black, white)	5.054	<.0001	2.866	7.242
WHtHR				
Age	0.005	0.195	-0.002	0.012
Gender	0.018	<.003	0.006	0.03
Race (black, white)	0.016	0.017	0.003	0.029

BMI = Body Mass Index; %BF = Percentage body fat; SSK = Sum of Skinfolds; FF = Fat Free mass; WHtHR = Waist-to-height-ratio

3. 5 Discussion

The purpose of this study was to determine the status of body composition and the effect of gender, age, and race on body composition. The reason for this is to examine the number of overweight adolescents and determine which gender and race is more overweight. With this information one might be able to create awareness among adolescents of the health risks brought about by their weight and persuade them to lead a healthier life style. Research on African and South African children living in rural areas on the body composition and prevalence of overweight and obesity rates will provide an opportunity to understand the role of development in children and adolescents and the importance thereof. From this study the results showed that girls are more overweight than boys. In addition, the results show significant gender, age, and race independent effects on body composition or BMI. The results of this current study coincide with existing literature. According to Del Rio-Navarro *et al.* (2004), Mexican girls had a higher prevalence of excess weight than boys. Mohammed *et al.* (2010) also stated in a recent study that Saudi girls also had a higher prevalence of excess weight than boys. Boutayeb and Boutayeb (2005); Prentice (2005); and Rossouw *et al.* (2012) clearly concluded that this overweight dilemma could be due to a decline in physical activity and diets rich in refined fats, oils and carbohydrates. The same results were found in a South African study by Truter *et al.* (2010); Armstrong *et al.* (2006); Reddy *et al.* (2008); Somers (2004); Makuddem-Peterson & Kruger (2004); Cameron and Getz (1997); and Jinabhai *et al.* (2003). All these studies correspond with the results of this study. As for the effect of gender, age and race, previous studies show that different factors play a role in gender disparity, such as the level of physical activity, and differences in the energy needs between boys and girls, as well as behavioural or cultural factors, and lastly the timing of sexual maturation (Kimani-Murage *et al.*, 2010). Armstrong *et al.* (2006) observed the following phenomenon that may be culture-related, where obesity increased with age in black girls and decreased with age in white girls. This correlates with the results in this study.

When this study is compared to other African studies the results are very similar. The total group of boys and girls showed a result of 29.1% underweight and 13.1% overweight compared to a study conducted in Nairobi (Kenya), which indicated results as 3.7% underweight and 14.4% overweight (Muthuri *et al.*, 2014). In a study from Nigeria, it was concluded that girls had a higher prevalence of overweight (20.3%) vs the boys (16.2%) (Musa *et al.*, 2012).This study is congruent with a previous mentioned study where the girls were more overweight than the boys (15.7% vs 9.1%). The study also correlates with a study by Wamba *et al.* (2013) stating that girls are more overweight than boys. As for the study performed in Ghana and Uganda, their values are lower than the values of this study. Their values indicated a prevalence of overweight of 10.4% among girls and 3.2% among boys and this could be due to smoking cigarettes and also loneliness among the children as well as under-nutrition (Peltzer & Pengpid, 2011).

The limitation of the study is the cross-sectional nature, which would limit the data to a certain point in time. A longitudinal design would therefore be more advantageous in terms of providing more definitive conclusions. The participants also vary from year to year in number and age. It should also be noted that this study consists of a large number of participants measured in a short amount of time. Besides the limitations it must be noted that the PAHL study measures over a period of time a birth cohort of a large number of participants of South African adolescents. The strength of this study is that it proves there is an overweight or obesity problem in children which can be detected during childhood and stopped before it reaches pandemic proportions.

3.6 Conclusion, limitations and recommendations

From this study it is clear that body composition (overweight) is a problem among adolescents, especially girls. It is also concluded that white boys have a high overweight value compared to black boys. This could be due to physical activity and nutrition. There is a very small difference between black and white girls' overweight value. As for the impact of gender, age and race on body composition the results show significant gender, age, and race independent effects on body composition of BMI. In addition, the results show no significant age independent effect on the body composition measures of percentage of body fat, sum of two skinfolds, fat free mass and waist-to-height ratio.

This situation should be cause for serious concern. All health and educational professionals of the country should be concerned about this emerging pandemic among children and adolescents. A possible solution to this problem of overweight could be to re-introduce PE as a subject in schools, focusing on lifelong physical activities, and teaching the learners appropriate skills and knowledge to evaluate their own health and wellness. Further to this, the teachers should send a message to learners as this may carry more impact.

This study also recommends that urgent preventative strategies be implemented to raise awareness about the health hazards of increased body weight. Also recommended is community-based wellness programmes to prevent overweight among children and adolescents.

3.7 Acknowledgements

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Disclaimer: Any opinions, findings and conclusions or recommendations expressed in this material are those of the author(s), and therefore the NRF and MRC does not accept any liability in this regard.

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CHAPTER 4: SUMMARY, CONCLUSION, LIMITATIONS, AND RECOMMENDATIONS

4.1 SUMMARY

The purpose of this study was to determine the status of body composition and the effect of gender, age, and race on body composition.

In Chapter One the problem statement, aim and hypotheses of the current study are stated and the structure of the study explained. In Chapter Two a literature review of body composition in children and adolescents is presented to define the concept of body composition in children as well as overweight and obesity and the effect of gender, age, and race on body composition. From the literature review it is clear that the concept of overweight and obesity, as well as body composition in children has been the focus of many researchers in the past decade. According to previous researchers, childhood overweight and obesity has already reached pandemic proportions globally, especially in developing countries. The literature review also clearly demonstrated a definite problem in body composition for children.

In Chapter Three the results of the body composition profiles of 14-year-old adolescents attending high schools in Tlokwe municipality are reported. The results indicate a total group BMI of 13.1% overweight, 29.1% normal weight, and 57.8% underweight. When boys and girls were compared, boys had an overweight of 9.1% vs. girls with 15.7%. When African girls were compared to Caucasian girls, the African girls showed 15.8% overweight vs. Caucasian girls with 15.4%.

As for the impact of gender, age, and race on body composition, results show significant gender, age, and race independent effects on body composition or BMI. The results also clearly showed no significant age independent effects on body composition measures of percentage body fat, sum of six skinfolds, fat free mass, and waist-to-height ratio.

4.2 CONCLUSION

The conclusions drawn from this research project are presented in accordance with the hypotheses set in Chapter One. The following hypotheses were set:

4.2.1 Hypothesis 1

The body composition profiles will show a low prevalence of obesity and fatness levels to be found among adolescent boys residing in the Tlokwe local municipality, while conversely a higher prevalence of obesity and fatness levels will be evident among adolescent girls residing in the Tlokwe local municipality.

According to the results discussed in Chapter Three, the prevalence of obesity and fatness levels among boys was lower than the girls (9.1% vs 15.7%). It is clear from this percentage that girls are more overweight than boys. It is also clear that from the figures drawn up in Chapter Three that the total group has a high percentage of overweight adolescents. This is a problem among youth as they are the future. It was also found that white boys have a higher percentage overweight than the black boys, and this could be due to differences physical activity levels and under-nutrition of black boys. As for the girl population, the percentage was slightly higher for overweight in black girls compared to their white counterparts. This could be due to levels of physical activity or stage of maturation. More studies are needed to determine the reason for these percentage differences.
Hypothesis 1 is therefore accepted.

4.2.2 Hypothesis 2

The impact of gender, age, and race on body composition will show significant gender, age and race independent effects on body composition, and no significant age independent effect on body composition measures of percentage body fat, sum of six skinfolds, fat free mass and waist-to-height ratio.

According to the results in Chapter Three, it was clear that there was a significant ($p < 0.05$) gender, age and race independent effect on body composition. The results also indicated no significant ($p > 0.05$) age independent effect on the body composition measures of percentage body fat, sum of six skinfolds, fat free mass and waist-to-height ratio. Hypothesis 2 is therefore, accepted.

4.3 LIMITATIONS AND RECOMMENDATIONS

It is clear from this study that body composition (overweight and obesity) is a problem among children and adolescents.

There are limitations and recommendations in this study that could improve the outcomes of further research.

4.3.1 One of the limitations of this study is the cross-sectional nature, which would limit the data to a certain point in time.

4.3.2 The participants also vary in number in terms of racial groups and age.

4.3.3 It should also be noted that a large number of participants must be measured in a short amount of time.

4.3.4 The children selected were limited by age and the small geographic location.

4.3.5 As for the recommendations, it is hoped that a longitudinal study is designed which would prove to be more advantageous in terms of providing more definitive conclusions.

4.3.6 It is also recommended that a possible solution to the problem of overweight and obesity, is by starting with school populations and re-introducing PE as a subject at schools, focusing on lifelong physical activities and teaching the learners appropriate skills and knowledge to evaluate their own health and wellness.

4.3.7 Teachers should be the primary tool to send messages to learners as this may carry more impact.

4.3.8 Also recommended is an urgent preventative strategy implemented to raise awareness about the health hazards of increased body weight.

4.3.9 And finally, it is recommended that a community-based wellness programme be implemented to prevent overweight among children and adolescents.

APPENDIX A

Mediterranean Journal of Social Sciences

www.mcser.org

Author Guidelines

General rules for text:

Please use the following rules for whole text, including abstract, keywords, heading and references.

Page setup

1. Margins: 1 Inch (2,54 cm) on all sides (top, bottom, left, right)
2. Font Size and Type: 12-pt. Garamond (preferred) or Times New Roman font
3. Line Spacing: Single space throughout the paper, including the title page, abstract, body of the document, references, appendixes, footnotes, tables, and figures.
4. Alignment: Justified
5. Orientation: portrait
6. Page size: A4

Preparation of text

1. Title: 14 pts, uppercase and lowercase letters bolded and centered
2. Name and personal information (academic title, institutional affiliation and e-mail address) should be placed under the title.
3. Abstract (150-250 words) and should include the following: aim, method, results and conclusion. The abstract must be written in Garamond or Times New Roman, Font Size 10 and Italic.
4. Keywords: up to 5 key words, Garamond or Times New Roman, Font Size 10 and bolded.
5. Spacing: Between abstract and main text, you should leave two empty lines.
6. Subdivision of the article: The papers should be structured in title and subtitle sections and should be numbered: 12 pts, alignment left (the abstract is not included in section numbering). Between title section and main text one empty line should be left.

Example of subdivision of the article:

1. Introduction
1.1 Research Methods
1.1.1 Analysis Result

Tables and figures should be included within the text of the paper and must be numbered.

References and Footnotes

References should follow the referencing style used by the American Psychological Association (APA) in alphabetical order. All sources cited in the paper must be included in the References section.

Citations in the text
Source material must be documented in the body of the paper by citing the author(s) and date(s) of the sources. Please ensure that every reference cited in the text is also present in the reference list (and vice versa). Avoid citation in the abstract. Unpublished results and personal communications should not be in the reference list, but may be mentioned in the text. Citation of a reference as "in press" implies that the item has been accepted for publication.

Citing and listing of web references

As a minimum, the full URL should be given. Any further information, if known (author names, dates, reference to a source publication, etc.), should also be given. Web references can be listed separately (e.g., after the reference list) under a different heading if desired, or can be included in the reference list.

Examples of references:

Reference to a journal publication:

Van der Geer, J., Hanraads, J. A. J., & Lupton R. A. (2000). The art of writing a scientific article. *Journal of Scientific Communications*, 163, 51-59.

Reference to a book:

Strunk, W., Jr., & White, E. B. (1979). *The elements of style.* (3rd ed.). New York: Macmillan.

Reference to a chapter in an edited book:

Mettam, G. R., & Adams, L. B. (1994). How to prepare an electronic version of your article. In B. S.
Jones, & R. Z. Smith (Eds.), *Introduction to the electronic age* (pp. 281-304). New York: E-Publishing Inc.

Reference to a web source:

Smith, Joe, (1999), One of Volvo's core values. [Online] Available: http://www.volvo.com/environment/index.htm (July 7, 1999)

Footnotes:

Content footnotes are occasionally used to support substantive information in the text. Place the footnotes at the end of the page: 10-pt. Garamond or Times New Roman.

APPENDIX B

NORTH-WEST UNIVERSITY
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

School of Biokinetics, Recreation and Sport Science
Private Bag x6001,
Potchefstroom
2520
South Africa
Tel: +27 18 299 1790
Fax: +27 18 299 1808
E-mail: andries.monyeki@nwu.ac.za
25 January 2010

The District Operational Director

Department of Education
North West Province
Potchefstroom

REQUEST TO CONDUCT RESEARCH WITHIN YOUR DISTRICT

Dear Sir,

We the researcher from the School of Bio kinetics, Recreation and Sport Science are hereby making a request to conduct research in the district under your authority.

To give the background of the study, research revealed that physical activity in adolescents is drastically declining. The decline in the level of physical activity of human populations has been observed, and such decline is been associated with increased mechanisation, reliance on technology and urbanisation, and the high rate of crime in South Africa and elsewhere in the world. Physical inactivity is thought to be one of the main risk factors for the development of obesity, diabetes, cardiovascular disease, osteoporosis and psychological constraints or risks of behavioural health.

Cross-sectional studies in South Africa which investigate the relationship between physical activity and determinants of cardiovascular disease for children and adults are available.

Findings from these study revealed inactivity was significantly related to the determinants of cardiovascular disease. Little from the abovementioned studies could investigate physical activity and determinants of cardiovascular disease on a longitudinal basis. It is therefore important to note that South Africa is a country of paradox where obesity in children co-exists with malnutrition and many other ailments of health. It is therefore, against this background that a longitudinal study investigating the development and tracking of physical activity and the determinants of cardiovascular diseases in South African adolescents is needed. Adolescence is a time when independence is established, and dietary and activity patterns may be adopted that are followed for many years. Most of the physiological, psychological and social changes within people take place during this period of life. The period of adolescence can be looked upon as a time of more struggle and turmoil than childhood. Adolescents have long been regarded as a group of people who are searching for themselves to find some form of identity and meaning in their lives. Thus, it has great influence on adult fatness and chronic disease of lifestyle as well as long-term outcome on quality of life. If youth health behaviours are tracked during adolescence, it would add support to the primary assumptions given for early interventions to prevent cardiovascular disease as well as delay in cognitive development. For this longitudinal study, tracking is defined as the stability of health behaviours over time, or the predictability of future values by early measurements. From the above given background, therefore, the aims of the study is to investigate over a five year period (2010-2014) a follow-up longitudinal development of physical activity and determinants of health risk factors of health behaviour in 14 years-old adolescents attending schools in Potchefstroom area of the North West Province of South Africa.

The above matter background information refers:

1. Permission is requested to conduct research in selected schools in your district as follows:

    1.1. BA Seobi Sec. School
    1.2. Tlokwe High School
    1.3. Resolofetse High School
    1.4. Botokwa High School
    1.5. Potchefstroom High School for Boys
    1.6. Potchefstroom High School for Girls
    1.7. Hoer Volkskool Potchefstroom
    1.8. Potchefstroom Gimnasium School

2. The targeted groups are boys and girls aged 14 years, in essence the grade 8 learners (NB: the proportion will be as follow: in mixed schools, 35 girls and 35 boys; in blacks schools 30 boys and 30 girls will be required).
3. The targeted term is the first term of 2010 (to be continued during the same term in the subsequent years up until 2014)
4. Items to be assessed or measured are:
4.1. Demographic information of the selected participants
4.2. Anthropomtric measurements (i.e. body height; weight; skin folds thickness (triceps, sub scapular and calf skin folds), and waist and hip circumferences)
4.3. Maturation (Tanner questionnaire)
4.4. Blood pressure measurement (mercury sphygmomanometer)
4.5. Physical activity questionnaire
4.6. ActiHeart (heart rate recorder with an integrated omnidirectional accelerometer. It is clipped onto two ECG electrodes worn on the chest.)
4.7. Health-related physical fitness (i.e. 20m shuttle run, standing broad jump, sit-and-reach, bent arm hang, sit-ups)
4.8. Social and self-efficacy questionnaire
4.9. Resting metabolic rate (determined by means of a mobile gas analyser)
4.10. Blood sampling (i.e. The participants will be requested to fast overnight (10 hours). A fasting sample of 10 ml blood will be taken from each participant in order to obtain ample blood for the various analyses of the study.)
4.11. Nutritional intake questionnaire.
4.12. Leisure and recreation constraint questionnaires
5. The schedule of the project will be as follow (Specific dates for selected schools will be finalised per arrangement with the principals concerned):

Month and week	Duration
April 2010, week 12 - 16	3 hours per child in a selected school
April 2010, week 19 - 23	3 hours per child in a selected school

Due to the fact that participants will be asked to fast 10 hours without eating breakfast in the morning, therefore sandwiches provision will be made available upon completion of the measurements. The outcomes of this project will benefit the children and the schools with the information regarding the physical activity status and the determinants of health for future.

Hoping for a positive response.

Yours sincerely,

Thank you,

Prof. M. Andries. Monyeki
(Principal Investigator, NWU-Potchefstroom)

Dr Hanlie Moss
Leader of Niche Area for Physical Activity, Sports and Recreation, NWU-Potchefstroom

APPENDIX C

NORTH-WEST UNIVERSITY
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South Africa
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Fax: +27 18 299 1808
E-mail: andries.monyeki@nwu.ac.za
10 March 2010
http://www.nwu.ac.za

INFORMATION LETTER TO THE PARENTS AND CONSENT FORMS: *PAHLS STUDY*

Dear Parent or Guardian,

Your child is been invited to participate in a study entitled – Five year Longitudinal Study of Physical Activity status and the Determinants of Health in Adolescents attending high school in Potchefstroom areas of South Africa (*PAHLS-Study, 2010–2014*).

My name is Professor Makama Andries Monyeki (from Potchefstroom Campus of the North-West University) principal investigator in the project together with the research team would like to ask your permission to allow your child (or a child under your care) to participate in our study. To give the background of the study, research revealed that physical activity in adolescents is drastically declining. The decline in the level of physical activity of human populations has been observed, and such decline is been associated with increased mechanisation, reliance on technology and urbanisation, and the high rate of crime in South Africa. Physical inactivity is thought to be one of the main risk factors for the development of obesity, diabetes, cardiovascular disease, osteoporosis and psychological constraints or risks of behavioural health. Therefore, the purpose of this study is to gather information about physical activity (i.e. by questionnaire & ActiHeart rate monitor) and health determinants (i.e. through measurements of anthropometry, maturation, blood pressure measurement, health-related physical fitness, social and self-efficacy questionnaire, resting metabolic rate, oxygen consumption (by the use of a portable gas analyser apparatus), blood sampling, leisure and recreation constraint questionnaires, nutritional intake questionnaire as questionnaire on risk factors of life) over a period of five years (2010–2014).

Participation in this study is not part of the child's regular classroom work; it is an optional activity in which the learner can choose to participate. The study will assess and test the following variables: anthropometric measurements, maturation, blood pressure measurement, health-related physical fitness, social and self-efficacy questionnaire, resting metabolic rate, oxygen consumption, blood sampling, leisure and recreation constraint questionnaires, nutritional intake questionnaire as questionnaire on risk factors of life. Blood samples will be collected by a registered professional nurse who will obliged to health profession practices at all times.

The data of the study will be used for research purpose only. The measurements will not be shared with your child classmates or teacher. All information collected in this study will be kept confidential. Your child's participation is important because the information that shall be gathered on him/her will help him/her with knowledge for personal development and life skills.

Your child participation in the project is very important, but it is entirely your choice. If your child choose to refuse to participate in any part of the study or withdraw from the study at any time, for any reason, this will not cause anyone to be upset or angry, and this will not results in any type of penalty.

There are no costs required from your child (or a child under your care) to participate in the study. Further, no payment will be granted to your child (or a child under your care) for participating in the study.

If you have any question regarding this study, please feel free to call me at (018) 2991790 / e-mail:andries.monyeki@nwu.ac.za or the PHASrec Niche Area Leader Dr Hanlie Moss at (018) 2991821 / e-mail:hanlie.moss@nwu.ac.za. If you have any questions regarding your rights or your child's rights as participants in this study you can call Ms Hannekie Botha at (018) 299 4850 from Potchefstroom Campus of the North-West University Research Ethics Office.

Thank you, in advance, for considering your child participation in this study. Should you choose that your child participate, please read and sign the attached consent form. Keep one consent form for your records and return the other copy. All received consent form will be kept locked during the entire period of the study. In addition, your child is requested to bring along his/her birth clinic card. The card will be given back to the child immediately after collecting information on birth date and birth weight. A child who shall have returned a completed and signed consent form will participate in the study.

Sincerely,

Prof. Makama Andries Monyeki

Principal Investigator – PAHLS Study

CONSENT FORM

(Parent/Guardian Copy)

FIVE YEAR LONGITUDINAL STUDY OF PHYSICAL ACTIVITY STATUS AND THE DETERMINANTS OF HEALTH IN ADOLESCENTS ATTENDING HIGH SCHOOL IN POTCHEFSTROOM AREAS OF SOUTH AFRICA (*PAHLS-STUDY, 2010–2014*).

I, ..., father/mother/guardian of ....
agree to permit my child to provide the information on physical activity (i.e. by questionnaire & ActiHeart rate monitor) and health determinants (i.e. through measurements of anthropometry, maturation, blood pressure measurement, health-related physical fitness, social and self-efficacy questionnaire, resting metabolic rate, oxygen consumption (by the use of a portable gas analyser apparatus), blood sampling, leisure and recreation constraint questionnaires, nutritional intake questionnaire as questionnaire on risk factors of life), by the researchers at my child school. I understand that the results of this study of Five year longitudinal study of physical activity status and the determinants of health in adolescents attending high school in Potchefstroom areas of South Africa (*PAHLS-STUDY NWP*) will be used for research purpose and nothing else. I am aware that if I have any question or concerns about the study I can contact the researcher at (018) 299 1790 or the PHASRec Niche Area Leader at (018) 299 1821. Any questions or concerns regarding my child rights as a participant in this study can be addressed to Ms Hannekie Botha at (018) 299 4850 from Potchefstroom Campus of the North-West University Research Ethics Office. I understand that there will be no discomfort or foreseeable risks for my child to participate in the study. I understand that all information my child provide will remain strictly confidential. I have read and understand the information provided above and in the information letter. I have been provided with the opportunity to ask questions and my questions have been answered satisfactorily. I consent to have my child participate in the study described above, understanding that he/she may refuse to participate in any part of the study and can withdraw from the study at any time. I have kept one copy of this consent for my records and will return the second copy with the clinic birth card. I am aware that by giving consent my

child can participate in the study. The return consent form will be kept locked during the entire period of the study.

Child's Age:.............................
Grade:...........................
Teacher:.....................................
School Name:...

Name of Child:...
Name of Parent/Guardian:...

....	....
(Signature of Child)	(Signature of Parent/Guardian)
....	....
(Date)	(Date)

NORTH-WEST UNIVERSITY
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NOORDWES-UNIVERSITEIT

CONSENT FORM (*PAHLS*)

(Return this copy with the demographic questionnaire)

FIVE YEAR LONGITUDINAL STUDY OF PHYSICAL ACTIVITY STATUS AND THE DETERMINANTS OF HEALTH IN ADOLESCENTS ATTENDING HIGH SCHOOL IN POTCHEFSTROOM AREAS OF SOUTH AFRICA (*PAHLS-STUDY, 2010–2014*).

I, ..., father/mother/guardian of ....
agree to permit my child to provide the information on physical activity (i.e. by questionnaire &ActiHeart rate monitor) and health determinants (i.e. through measurements of anthropometry, maturation, blood pressure measurement, health-related physical fitness, social and self-efficacy questionnaire, resting metabolic rate, oxygen consumption (by the use of a portable gas analyser apparatus), blood sampling, leisure and recreation constraint questionnaires, nutritional intake questionnaire as questionnaire on risk factors of life), by the researchers at my child school. I understand that the results of this study of Five year longitudinal study of physical activity status and the determinants of health in adolescents attending high school in Potchefstroom areas of South Africa (*PAHLS-STUDY NWP*) will be used for research purpose and nothing else. I am aware that if I have any question or concerns about the study I can contact the researcher at (018) 299 1790 /e-mail:andries.monyeki@nwu.ac.za or the PHASRec Niche Area Leader at (018) 299 1821 /e-mail:hanlie.moss@nwu.ac.za. Any questions or concerns regarding my child rights as a participant in this study can be addressed to MsHannekie Botha at (018) 299 4850 from Potchefstroom Campus of the North-West University Research Ethics Office. I understand that there will be no discomfort or foreseeable risks for my child to participate in the study. I understand that all information my child provide will remain strictly confidential. I have read and understand the information provided above and in the information letter. I have been provided with the opportunity to ask questions and my questions have been answered satisfactorily. I consent to have my child participate in the study described above, understanding that he/she may refuse to participate in any part of the study and can withdraw from the study at any time. I have kept one copy of this consent for my records and will return the second copy with the clinic birth card. I am aware that by giving consent my child can participate in the study. The return consent form will be kept locked during the entire period of the study.

Child’s Age:............................

Grade:...........................

Teacher:.....................................

School Name:...

Name of Child:...

Name of Parent/Guardian:...

....	....
(Signature of Child)	(Signature of Parent/Guardian)
....	....
(Date)	(Date)

APPENDIX D

PAHLS Project - Anthropometry Proforma

Subject number:	

Name: .... Sport: ....

Surname first names

Date of Birth:			
	Day	Month	Year

Test Date:			
	Day		Month

Year

Box height: ....

Gender: M ☐ F ☐

	ID	*Site*	*Trail 1*	*Trail 2*	*Trail 3*	*Mean/ Median*
Basic	1	Body mass				
	2	Stature				
	3	Sitting height				
	4	Armspan				

Skinfolds	5a	Triceps : R				
(SF)	5b	Triceps : L				
(mm)	6a	Subscapular : R				
	6b	Subscapular : L				
	7a	Biceps : R				
	7b	Biceps : L				
	8a	Supraspinale : R				

	8b	Supraspinale : L				
	9	Abdominal : R				
	10a	Front thigh : R				
	10b	Front thigh : L				
	11a	Medial calf : R				
	11b	Medial calf : L				

Girths	12	Head				
GR	13a	Arm (relaxed) : R				
(cm)	13b	Arm (relaxed) : L				
	14a	Arm (flexed & tensed) : R				
	14b	Arm (flexed & tensed) : L				
	15	Waist (minimum)				
	16	Gluteal (hips)				
	17a	Thigh (mid) : R				
	17b	Thigh (mid) : L				
	18a	Calf (maximum) : R				
	18b	Calf (maximum) : L				

Breadths	19	Wrist				
BR	20	Ankle				
(cm)	21	Foot length				
	22	Humerus				
	23	Femur				